Strategy Research Project

# CRAFTING THE DEPARTMENT OF DEFENSE ENERGY STRATEGY

BY

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USAWC CLASS OF 2010

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# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| | | |
|---|---|---|
| 1. REPORT DATE<br>**30 MAR 2010** | 2. REPORT TYPE | 3. DATES COVERED |
| 4. TITLE AND SUBTITLE<br>**Crafting the Department of Defense Energy Strategy** | | 5a. CONTRACT NUMBER<br>5b. GRANT NUMBER<br>5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S)<br>**Curtis Zablocki** | | 5d. PROJECT NUMBER<br>5e. TASK NUMBER<br>5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)<br>**U.S. Army War College ,122 Forbes Ave.,Carlisle,PA,17013-5220** | | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | | 10. SPONSOR/MONITOR'S ACRONYM(S)<br>11. SPONSOR/MONITOR'S REPORT NUMBER(S) |
| 12. DISTRIBUTION/AVAILABILITY STATEMENT<br>**Approved for public release; distribution unlimited.** | | |
| 13. SUPPLEMENTARY NOTES | | |
| 14. ABSTRACT<br>**see attached** | | |
| 15. SUBJECT TERMS | | |

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT<br>**unclassified** | b. ABSTRACT<br>**unclassified** | c. THIS PAGE<br>**unclassified** | | **38** | |

**Standard Form 298 (Rev. 8-98)**
Prescribed by ANSI Std Z39-18

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USAWC STRATEGY RESEARCH PROJECT

# CRAFTING THE DEPARTMENT OF DEFENSE ENERGY STRATEGY

by

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**ABSTRACT**

AUTHOR: Lieutenant Colonel Curtis J. Zablocki

TITLE: Crafting the Department of Defense Energy Strategy

FORMAT: Strategy Research Project

DATE: 22 March 2010 WORD COUNT: 8,129 PAGES: 38

KEY TERMS: Fuel, Electricity, Climate Change, Military

CLASSIFICATION: Unclassified

The enormous use of energy by the Department of Defense (DoD) has a tremendous impact on the current and future security of our nation. This paper first examines the extent of DoD energy use. It identifies the vulnerabilities to U.S. national security stemming from an overreliance on foreign oil and a fragile commercial power grid. It looks at the costs of inefficient, fuel-intensive systems and operations in terms of dollars, opportunity, and lives. It addresses the security threats from global climate change aggravated by burning fossil fuels. It describes a set of end states that a smart energy strategy should hope to achieve. It lists the key objectives of an energy strategy and explores the ways to achieve these objectives. It looks at the legislation, executive orders, plans and actions taken thus far by the government and within DoD to attack these challenges. Finally, as the effects and vulnerabilities of the DoD's energy policies interact and overlap, this paper concludes with recommendations for the way ahead toward a coordinated, holistic, consistent, and comprehensive energy strategy.

CRAFTING THE DEPARTMENT OF DEFENSE ENERGY STRATEGY

To provide the United States with unparalleled power projection, agile combat maneuverability, and persistent global engagement, the U.S. military requires an enormous amount of energy. From jet fuel for fighter aircraft, to electricity for command and control operations centers, to diesel for naval vessels, the U.S. military lives on energy.

The enormous use of energy by the Department of Defense (DoD) has a tremendous impact on the current and future security of our nation. Our nation's and our military's use and reliance on foreign oil create vulnerabilities to our national security and transfer wealth and power to our competitors and enemies. Our military's dependence on the commercial electric power grid leaves our bases and critical capabilities vulnerable to the effects of cyber and kinetic terrorism, natural disaster, and warfare. Our military's inefficient use of energies imposes tremendous costs in terms of money, opportunity, and lives, and creates burdensome logistic trails that impact the tactical agility, stealth, robustness and endurance of our forces. Finally, our large use of fossil fuels accelerates global climate change and exacerbates a host of corresponding threats and complications to our future national security. As the effects and vulnerabilities of the Department of Defense's energy policies interact and overlap, we see a need to clarify and coordinate a holistic, consistent, and comprehensive energy strategy.

This paper first examines the extent of DoD energy use. It identifies the costs and vulnerabilities to U.S. national security of this energy use. It describes a set of end states that a smart energy strategy should hope to achieve. It lists the key objectives of an energy strategy and explores the ways to achieve these objectives. It looks at the legislation, executive orders, plans and actions taken thus far by the government and within DoD to attack these challenges. Finally, this paper concludes with recommendations for the way ahead.

Background

The Department of Defense is the nation's single largest consumer of energy, using more than any other organization, public or private.[1] To put this into perspective, DoD is responsible for more than 80 % of the U.S government's total energy consumption and over 1% of the nation's total consumption.[2] In 2008 the DoD used about 900 trillion BTUs of energy—more than the entire country of New Zealand.[3] Of the energy that DOD uses, about 74% of total energy costs go to petroleum-based fuel for mobility—airplanes, ships, ground vehicles—the majority of this being jet fuel.[4] About 22% of DOD's energy costs are for facilities—primarily electricity and natural gas. About 85% of the energy infrastructure that DoD depends upon is commercially owned and 99% of the electrical energy DoD installations consume come from outside installations.[5]

Several factors have contributed to the growth in energy use of our military over the years. These factors include the increased mechanization and electrification of warfighting technologies and the expeditionary nature of conflict requiring mobility over long distances and across rugged terrain. Wartime use of fossil fuels has increased steadily since WWII. As of 2007, fuel consumption of U.S. forces in Operation Iraqi Freedom and Operation Enduring Freedom averaged about 22 gallons per soldier per day.[6] Despite significant advances in fuel efficiencies for internal combustion and jet engines, a recent Deloitte study has concluded the average daily fuel consumption per soldier is expected to increase at about 1.5% per year through 2017.[7] This huge, and growing, requirement for energy leaves the U.S. military with very real vulnerabilities.

*Dependence on Oil.* Our nation's and our military's demand for oil is perhaps the largest energy-related vulnerability to national security. In his 2007 State of the Union address, President Bush said our dependence on foreign oil "leaves us more vulnerable to hostile regimes and to terrorists who could cause huge disruptions of oil shipments and raise the price of oil and do great harm to our economy."[8] In 2007, the U.S. consumed 7.5 billion barrels of oil.[9] Our military burns a tremendous amount of this oil. In Fiscal Year (FY) 2003, with the U.S. invasion of Iraq, the DoD purchased over 145 million barrels of petroleum.[10] Annual use of petroleum for DoD fluctuates from year to year as missions dictate, but in FY 2008 DoD purchased 132.5 million barrels[11] – about 1.75% of the nation's total consumption. With less than 5% of the world's population, the U.S. accounts for 10% of the world's oil production, consumes 25% of the world's oil production, and holds an estimated mere 1.6% of the global reserves of recoverable oil.[12] In 2007 the U.S imported 58% of the oil it consumed.[13] The Energy Information Administration predicts the percentage of total oil consumed by the U.S. that is imported will decline only minimally in the next two decades – to 53% in 2020 and 56% by 2030.[14] And as the worldwide demand for oil increases, competition for these supplies will only increase.

Many of the oil rich countries, such as Venezuela and Iran, hold political values antithetical to U.S. interests. Oil revenues have, for instance, allowed Iran to increase its military spending from $1.77 billion in 1998 to $8.4 billion in 2008.[15] These revenues have also helped Iran finance activities of Hizballah.[16] Venezuelan President Hugo

Chavez relies on oil to fund over one half of his government's revenues. Consistently opposing U.S. policy initiatives at the U.N. and elsewhere, Chavez has also used this money to support movements seeking to destabilize neighboring governments. A RAND study has concluded "Revenues from oil exports have enabled Chavez to pursue a number of policies that run counter to US goals."[17] Our thirst for oil transfers American dollars to these and other regimes hostile to U.S. interests, increasing their political leverage as well as providing funding for terrorist networks. As the Defense Science Board stated, "Our need to maintain good business relations with oil exporting countries complicates our foreign policy options. Some of them are known to support extremist groups. In effect, through our imports of oil we help to fund both sides of the global war on terror."[18] The U.S. contributes to the economic and political leverage of these and other oil-exporting countries even when we do not directly purchase supplies from these countries. Our nation's sheer demand for oil inflates world oil prices and corresponding revenues for these exporters. Other oil exporting countries are fragile states such as Nigeria and Russia which creates yet another vulnerability. Unrest in oil-producing countries increases risk to supplies, increases market volatility, and further inflates global prices for oil and related industries.

Finally, the strategic importance of oil to our nation, our military, and the world economy requires that our military will now, and into the foreseeable future, continue to be called upon to stabilize and protect oil-rich parts of the world. U.S. forces are deployed to the Persian Gulf and other regions of the world for various missions, so determining the exact amount spent to secure the transit of oil is difficult, but different analyses estimate the U.S. spends between $29 billion and $143 billion every year just to protect the supply and transit of oil.[19] This dependence on foreign nations for our supply of oil creates numerous challenges that conflict with national security goals. Beyond oil, there are other aspects of our energy supply that leave our national security vulnerable.

*Electricity*. The vulnerabilities to our security due to our nation's electrical power supply are different than oil. The U.S. has strong domestic energy supplies to adequately meet the electrical needs for the nation and our domestic defense installations. The vulnerability here is our reliance on an extremely fragile commercial electrical power grid to transfer this energy.[20] Threats to our electric supply come from an increased demand on the aging grid, growing reliance on computer-controlled automation susceptible to cyber attack, and a physical infrastructure susceptible to terrorist attacks and natural disasters.[21] According to the Government Accountability Office (GAO), the DoD relies on a network of "defense critical infrastructure" so crucial to national security that destroying or incapacitating an asset within this network would "severely affect DOD's ability to deploy, support, and sustain its forces and operations worldwide and to implement its core missions, including those in Iraq and Afghanistan as well as its homeland defense and strategic missions."[22] All 34 of the top components of this defense critical infrastructure require a continuous secure supply of electricity and 31 of these rely on electricity primarily from the commercial power grid.[23] The DoD has traditionally believed risk of electricity disruptions is low and temporary disruptions could be handled with diesel generators and a limited supply of fuel. But according to GAO and the Defense Science Board, the military's backup power is inadequate for lengthy or widespread outages and presents an "unacceptably high risk" to national security and homeland defense.[24] Power outages create a host of other complications as well. For instance, military logistic chains run on a just-in-time delivery system similar to the business world. Loss of power could disrupt supply depot operations, severely affecting military operations. Power outages can also hamper other parts of the commercial infrastructure, like refineries, creating powerful second and third order effects.

An example of the fragility of our power grid occurred on August 14, 2003 when a tree fell across a power line and created a blackout across northeast America and Canada affecting 50 million people in a 9,300 square mile area. Although many areas saw their power restored within hours, a few areas waited for almost a week. This relatively benign outage had second order effects including sewage system failures causing illness from drinking unclean water; it shutdown many refineries on the East Coast; and it created delays to rail, air and trucking transportation.[25] All told, the Department of Energy estimated the total cost of the outage to be around $6 billion.[26]

Electrical power for our bases beyond the U.S. has risks as well. Many of our installations in countries such as Germany and Japan rely on local commercial power grids and share similar vulnerabilities to domestic bases mentioned above. For our forward operating bases with nonexistent or unreliable commercial power grids, DoD must provide electrical power organically, usually through jet fuel or diesel powered generators. Producing this energy takes a tremendous amount of fuel. In fact, the DoD reports that the single largest battlefield fuel consumer is not weapon systems, but generators, which provide power for base support activities such as cooling, heating, and lighting.[27] The logistical burden of transporting this fuel creates enormous costs and risks. In 2006, Marine Major General Richard Zilmer realized one of the most dangerous tasks for his Marines in Iraq's Anbar Province was driving trucks to isolated posts with fuel for generators. He sent a request to the Pentagon urgently requesting alternatives.[28] In 2007, about 70% of U.S. Central Command's energy budget was being spent just moving fuel.[29] Realizing the best way to defeat a roadside improvised explosive device, or IED, is to not be on the road at all, the U.S. Army's Power Surety Task Force began to look at ways to improve energy efficiencies and ways to produce renewable electrical energy on-site.[30] There have been some notable improvements in tent insulation and generator efficiencies, but a report from the GAO released in 2009 states that transporting fuel to forward-deployed locations still "presents an enormous logistics burden and risk, including exposing fuel truck convoys to attack" and urges DoD to more aggressively address this vulnerability.[31]

*Costs.* The sheer dollar cost of the energy is a huge burden to the military and creates its own set of vulnerabilities. DoD fuel costs increased from $3.6 billion in FY2000 to nearly $18 billion by FY2008—a five-fold increase—while actual volumes purchased had only increased by 30% over the same time.[32] The percentage of the DoD budget for energy has also increased, more than doubling from 1.2% in 2000 to 3.0% in 2008.[33] At the current usage rate of approximately 130 million barrels of oil a year, every $10 per barrel increase in oil prices costs the U.S. military an additional $1.3 billion dollars. Energy for facilities at our DoD installations, primarily electricity and natural gas, is another huge cost. In FY 2008 the DoD spent $3.95 billion on facility energy.[34] More of the budget that must be spent on energy is less that can be spent on other Defense programs which, beyond dollars, creates a huge opportunity cost.

How we account for the cost of energy is more complicated than one may initially think. The cost of jet fuel from suppliers averages about $3 per gallon, but when considering the machine- and manpower-intensive logistic trail required to transport the fuel to the end user—much of the fuel being used in the vehicles transporting the fuel itself—the cost of this fuel is much higher.  The DoD's Defense Science Board coined the term "fully-burdened cost of fuel" to account for these costs. This fully-burdened price is about $42 per gallon for in-flight refueling and up to several hundred dollars a gallon for ground units deep within a battle space.[35]

But dollar costs are not the only concern. The sheer weight of this logistical burden is huge. For example, roughly one half of logistics tonnage for operations in places like Iraq is fuel.[36] This logistical burden hinders the flexibility, agility, maneuverability, stealth, and endurance of our forces, truly impacting the military's efficacy. The Defense Science Board says this "high and growing demand for battle space fuel compromises operational capability and mission success."[37]

This movement of fuel—the majority of which goes to power equipment other than combat vehicles—exacts a tremendous cost in terms of lives. A 2009 Deloitte study noted the increasing number of convoys required to transport this fuel is itself a root cause of many IED-related casualties in Operation Iraqi Freedom (OIF). Despite the military's growing appreciation of this threat, the study found "absent game-changing shifts, the current Afghan conflict may result in a 124% (17.5% annually) increase in U.S. casualties through 2014, should the war be prosecuted with a similar profile to Operation Iraqi Freedom."[38]

The costs, therefore, of a heavily energy-burdened military are real dollars that could be spent on other programs, decreased combat capabilities because of logistics requirements, and lives of servicemen and contractors delivering and defending energy supplies. But there is another threat to national security stemming from DoD energy use. This threat has no boundaries and is a threat, not of intent, but of context. It is the worldwide threat of global climate change.

*Global Climate Change.* Climate change presents yet another vulnerability to national security. President Obama, in his December 10, 2009 Nobel Peace Prize acceptance speech in Oslo, Norway, acknowledged this when he called on the world to come together to confront climate change. “There is little scientific dispute that if we do nothing, we will face more drought, more famine, more mass displacement – all of which will fuel more conflict for decades. For this reason, it is not merely scientists and environmental activists who call for swift and forceful action – it's military leaders in my own country and others who understand our common security hangs in the balance.”[39] He was correct in recognizing that military leaders are calling for action to curb global climate change. Michèle Flournoy, DoD’s Under Secretary for Policy, said global climate change is “going to accelerate state failure in some cases, accelerate mass migration, spread of disease, and even possibly insurgency in some areas as weak governments fail to cope with the effects of global climate change.”[40] The Center for Naval Analysis Military Advisory Board, consisting of eleven of the nation’s most respected retired admirals and generals, released a report in 2007 titled “National Security and the Threat of Global Climate Change” which states, “Climate change can act as a threat multiplier for instability in some of the most volatile regions of the world, and it presents significant national security challenges for the United States."[41] The potential effects of climate change include reduced access to fresh water, impaired food production, health catastrophes, land loss, flooding, and displacement of populations. This creates greater potential for failed states, and the growth of terrorism, mass migrations, disenfranchised diasporas, and increased conflict over resources.[42] Increased storm activity could put at greater risk our own energy infrastructure such as oil refineries and components of the electrical power grid as well as our coastal military bases. As oceans warm and polar ice continues to melt, rising sea levels will affect not only unfortunate Maldivians but also many of our own U.S. bases. For instance, Diego Garcia, an atoll in the Indian Ocean which serves as a logistic and strategic hub for U.S. and British forces, is only a few feet above sea level at its highest.[43] Congress has acknowledged this threat as well. The 2008 National Defense Authorization Act required that the next national security strategy, national defense strategy, and quadrennial defense review include guidance on the effect of projected climate change on current and future DoD missions.[44]

End States

This paper has so far discussed the national security vulnerabilities due to supplies of oil and electricity, the costs and burdens of DoD's dependency on energy, and the threat of global climate change. In developing a sound energy strategy it may be useful to try to identify the end states DoD would hope to achieve. Of course an energy strategy will never have a perfect end state after which the battle is over and energy will no longer be a concern. DoD will always be reliant on energy, and there will always be some vulnerabilities, costs, and threats derived from its use. We can envision an end state perhaps 50-100 years in the future where an increasingly populated, mechanized, and electrified world is no longer plagued by the struggle for energies nor its environmental effects. This very long term end state would see an adequate worldwide supply of available, sustainable, and environmentally friendly energy as well as technological and cultural advances that promote energy efficiencies. Perhaps fusion reactors or other yet to be developed technologies will be the answer for our grandchildren's world. DoD should keep an eye open to the very long term, but as any technology capable of this level of game-changing is still, by most scientific estimates, at least 50 years away, DoD needs to focus on the next few decades. The DoD could strive for end states that would eliminate or minimize these energy-related threats to our security within the next two decades. The author proposes the following as a starting point:

- DoD significantly less dependent on oil
- DoD immune to spikes in oil prices and disruptions in foreign oil supply
- Reduced monetary burden of DoD energy both in terms of total price and percentage of budget
- All DoD installations capable of operating indefinitely in event of commercial power grid failure
- All Forward Operating Bases capable of operating on sustainable, renewable energy
- Increased agility, sustainability and stealth through decreased energy logistical and support requirements for all types of systems
- Few to no servicemen or contractor deaths transporting fuel
- Total DoD energy use carbon-neutral or better and environmentally friendly

Objectives

Strategies to reach these end state conditions have overlapping solution sets. To achieve these end states we need to identify the most basic key objectives of a comprehensive energy strategy for DoD. These objectives are simply to reduce demand for energies, assure supply of energies, and minimize net greenhouse gas emissions. These key objectives are constrained by the need to continue to accomplish the mission of defending and securing the nation and its interests. They also are restrained by the fiscal limits of the DoD budget authority both now and in a fiscally-challenged future. To the extent that accomplishment of these objectives by the rest of the United States, public and private, will aid in our nation's security, these objectives should be approached with the intent of influencing the rest of the nation outside of the DoD.

*Reduce Demand.* Reducing demand for energy is the most direct way to lower costs for energy resources and related logistics and to reduce reliance on sources external to the DoD. Generally, demand is reduced through conservation and efficiencies. Conservation efforts focus on reducing usage. Turning off the lights when leaving the office is an example as would be flying fewer training sorties or deploying fewer troops. Conservation efforts can realize immediate cost savings but can only go so far before putting mission accomplishment at risk. Increasing efficiencies is another way to reduce demand. Efficiencies involve getting "more bang for the buck." Using energy efficient light bulbs and accomplishing combat training during what would otherwise be a routine aircraft delivery are examples of efficiencies. Efficiencies do not adversely impact the mission and can be gained through improved processes and through better technologies of equipment used for both energy production and use.

Demand for one type of energy can sometimes be reduced by transferring this demand to another type of energy that is perhaps more efficient, less vulnerable, less costly, and/or less environmentally damaging. For instance, ground transportation vehicles that burn gasoline could be replaced by plug-in hybrid electric vehicles (PHEV) that run off of electricity produced from coal, nuclear, or renewable sources. Internal combustion engines are very inefficient, wasting about 80% of the energy of combustion in the form of excess heat.[45] Electric motors in PHEVs and electrics generators are, in contrast, very efficient. Even if the sole source of electricity was coal (currently roughly half the nation's electricity comes from coal), first generation PHEVs reduce greenhouse gas emissions by about 30% compared to gasoline powered vehicles. Recent studies have shown with today's driving patterns, and with today's electrical power sources, PHEVs would reduce greenhouse gas emissions from by 27% to 37% as well as reducing a host of other pollutants.[46] When compared to comparable gasoline-powered vehicles, PHEV would lower driving costs to equivalent gasoline prices of about 75 cents per gallon.[47] Finally, as there is a much lower demand for electricity at night when most of these vehicles would be charging, the impact to the electric grid would be minimal. In fact, a recent study found that "more than 200 million plug-ins could be driven daily in the U.S. without the need for new electric generating capacity."[48] Many weapons systems, such as jet aircraft, are reliant on the energy-dense chemical liquids like jet fuel and do not lend well to electrification. Here, though, conventional petroleum jet fuel can be replaced by synthetic fuels derived from coal, natural gas, or biomass. While not reducing overall energy demand, such a tactic can help reduce demand of the

DoD's most costly and risky supply – foreign oil – and it will address the second objective of assuring supply.

*Assure Supply.* The second key to addressing our energy challenges is that of assuring we have access to an adequate supply of energy. Reducing demand makes assuring supply easier because *less* supply is required to be considered *adequate*. When addressing supply directly, two elements of assuring supply are to control the production of the energy supply – primarily liquid fuel, gas, and electricity in DoD's case – and to control and protect the distribution of the energy – power grids, natural gas lines, fuel convoys, sea lanes, etc. The ability to produce energies locally, for instance through domestically-produced fuels or mobile solar-powered generators, facilitates both elements of controlling production and distribution.

Our reliance on foreign oil is a key vulnerability. One way to help assure supply of oil is to produce adequate quantities domestically. Expanding domestic oil production will lower global oil prices and reduce incomes for rogue oil exporters, but there are limits. The U.S. is estimated to control a mere 1.6% of the global reserves of recoverable oil.[49] Because of the long lead times involved with developing new oil fields, it takes roughly a decade to bring significant quantities of new supplies to market.[50] Opening environmentally sensitive areas such as the Outer Continental Shelf and the Arctic National Wildlife Refuge to drilling could, at their peak in 2025, add to global supply between 4 to 11% of forecast U.S. demand.[51] The U.S. may also be able to increase domestic production of mobility fuels thorough alternative fuel technologies. Synthetic fuels can be made from other fossil fuels through a variety of proven and developing processes. Coal, natural gas, oil sands and oil shale can be converted to a synthetic fuel, though at high costs both economically and environmentally. One study concluded domestic production of coal-to-liquid fuels in the U.S. could reach 2 to 3 million barrels per day by 2025.[52] However, on a well-to-wheel basis, this technology releases about twice the amount of greenhouse gas as the equivalent amount of petroleum fuel as well as having other environmentally adverse affects.[53] Jet fuels, diesel and ethanol can also be produced domestically from various biomasses – corn, cellulose, and algae for example – with varying costs and with varying degrees of net greenhouse gas emission.

A report commissioned by the U.S. Department of Energy noted that the U.S. electrical grid must be efficient, accommodating, opportunistic, and resilient.[54] These same qualities can be applied to the production of energy at the installation, microgrid, or tactical generator level as well. *Efficiency* in this context means the system should be able to meet increased demand without adding much infrastructure. An *accommodating* system means the energy plant must be able to accept various forms of energy. For instance, an electrical generator able to run on solar, wind, methane, or jet fuel as the time of day, weather, and available energy sources dictate is an accommodating supplier of electricity. This attribute applies to electrical generators but the same concept also applies to combat and support vehicles. Flex fuel vehicles and plug-in electric hybrids are examples of systems capable of accommodating various fuel types. Electrical generators and microgrids should be *opportunistic* – able to capitalize on plug-and-play innovation as market and technology changes as well as being able to integrate new technologies and fuels as they come on line. These systems also need to be *resilient* or resistant to enemy attack, unintended damage, or natural disaster. Decentralized and networked supply chains aid in improving resilience.[55]

Lastly, assuring supply requires securing the lines of supply and protection of the critical energy infrastructure. Locally produced energies require less infrastructure and shorter lines of supply. They can also reduce vulnerabilities created by the reliance on external actors. Locally produced energies also take less energy to transport, reducing overall demand. This reduced burden can increase the agility and endurance of military forces.

*Reduce Greenhouse Gas Emissions*. The third key objective is aimed at reducing the risk to national security due to global climate change. The foremost authority on climate change is the International Panel on Climate Change—an international scientific body established by the United Nations to "review and assess the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change."[56] Thousands of scientists with disparate viewpoints from all over the globe contribute to the IPCC reports which remain policy-relevant yet policy-neutral. The reports show scientists overwhelmingly agree human activity has increased the average global temperature of the earth well beyond the effect of known natural processes such as volcanic eruptions and solar changes. Since the beginning of the industrial age, and particularly in the past 50 years, human activity has increased the "radiative forcing" – the measure to which the energy of the earth-atmosphere system is changed – by somewhere between 0.6 and 2.4 watts per square meter. This has increased the average global temperature and contributed to accelerated global climate change.[57] The main source of this anthropogenic (human-caused) warming is excessive net greenhouse gas emissions, particularly carbon dioxide, from the burning of fossil fuels.[58]

There are two basic types of strategies to combat the threat of global climate change – they are adaptation and mitigation. Adaptation involves taking steps to adapt to known or forecast effects due to changing climate. This may include hardening U.S. military facilities against hurricanes, increasing foreign internal defense assistance so nations affected by increased drought and famine are better able to provide domestic humanitarian assistance and security, or changing naval force structure to accommodate patrolling an Arctic with less sea ice. Further discussion on adaptation methods are beyond the scope of a paper on energy strategy apart from recognizing that the effects of energy use will necessitate DoD take measures to adapt to a world affected by climate change.

The second global climate change strategy is mitigation, which involves reducing the anthropogenic radiative forcing that accelerates global climate change, primarily, as discussed earlier, through reducing net greenhouse gas emission. The most direct way to do this is to reduce the amount of fossil fuel burned. Reducing total DoD demand for energy will aid in achieving this objective. Truly renewable energies have a negligible or no impact on greenhouse gas emission. The only greenhouse gas emissions from wind or solar energies are from whatever fossil fuels are used during the production, installation, and maintenance of the equipment. Biofuels have varying degrees of net emissions. Because corn ethanol production uses a tremendous amount of petroleum to fertilize, cultivate, transport and process the grain, estimates of its effect on net greenhouse gas emissions range from being only slightly better than gasoline to being an even worse net greenhouse gas emitter than gasoline.[59] Other feedstock, particularly those that do not require fertilizers and do not replace food crops, can have a much more positive effect. By increasing the proportion of truly renewable energies in our energy supply, we will reduce the amount of greenhouse gas emissions.

Another way to reduce net greenhouse gas emissions is to capture and sequester carbon dioxide. As it is easier to capture carbon dioxide at the source of burning than from the atmosphere, these techniques typically involve capturing the carbon dioxide at fixed sources, primarily at coal-burning electrical power plants, then sequestering it in vacated underground reservoirs left over from oil or gas extraction, deep saline aquifers, or most promising, in undersea basalt layers. This technology has yet to be proven on large scales and over lengthy periods of time. Other techniques involve using excess carbon dioxide to feed biofuel feedstocks such as algae at a co-located energy production site. These carbon capture and storage ideas should be explored, but the primary methods of increased energy efficiencies and increased renewable energy sources should be DoD's areas of focus.

*Constraints and Restraints.* The constraint for implementing the key objectives of reducing demand, assuring supply, and reducing greenhouse gas emission is that the DoD cannot allow pursuit of these objectives to add unacceptable risk to mission capabilities. Increased platform efficiencies, reduced logistic requirements, and secure sources of energy cannot help but increase mission effectiveness. An overly zealous approach to fuel conservation could affect combat effectiveness if, for example, on-vehicle weapon system training is decreased to a level that compromises operator skill. By far, most actions taken to reduce demand and assure supply will advance combat and mission effectiveness. Likewise, actions taken to reduce greenhouse gas emissions should decrease the likelihood and severity of future military operations.

Achieving these objectives is fiscally restrained by the DoD budget. The DoD can assume risk in other programs to help fund smart energy strategy requirements. America's growing national debt will certainly limit growth of the DoD budget of the future. An energy strategy should seek to decrease the long-term and fully-realized costs to the U.S. taxpayer. The upfront costs for efficiency technologies and renewable energies may be high but will pay for themselves over time. A smart energy strategy, by definition, will balance costs and risks. Given the scale of the vulnerabilities, the projected increased cost of oil, and the costs of future conflicts aggravated by climate change, increased expenditures on the total energy strategy should still realize overall long-term cost savings to the American taxpayer.

*Influence Beyond DoD.* The span of *control* of DoD is, of course, limited to that which is in DoD itself—its people, its processes, its technologies, its budget, its contracts. The span of *influence* of the DoD, however, extends well beyond the Department. Although DoD is the largest single consumer of energy in the U.S., it still accounts for less than 2% of the nation's total. In as much as the nation's use of and reliance on energies contribute to vulnerabilities to our economic well-being and national security, DoD strategy should seek to influence the whole of America, both public and private, to advance smart energy choices. The same is true with respect to global climate change, only DoD should also seek to influence actors beyond our own nation. As the entire world contributes to and feels the effects of global climate change, actions we take that influence the *worldwide* reductions in greenhouse gas emissions will enhance our own national security.

Ways

How, then, does DoD achieve these objectives of reducing demand, assuring supply, and reducing greenhouse gas emissions? The ways are to collect appropriate metrics, spend money up front, advance research and development, learn from civilian industry, leverage partnerships with civilian industry, and change the culture.

*Metrics.* Steps to reduce energy use first require the capture of meaningful metrics. These metrics must align actions with the objectives of reducing demand, assuring supply and reducing greenhouse gas emissions. To effect change, one needs first to capture and quantify all aspects of energy use. For too long energy use was not adequately tracked in the military. This was an institutional and cultural product of decades of low energy costs and large defense budgets. The Defense Science Board's 2008 Energy Task Force was struck by the contrast between the energy demand metrics collected by the military and the civilian business world. "If a single freezer cabinet door remains open too long at an individual store, an alarm is triggered at Wal-Mart's headquarters in Bentonville, AR."[60] Wal-Mart uses detailed energy-use metrics to inform corporate decisions including investments, maintenance policies and operational procedures.[61] Smart metrics capture energy use and carbon footprints and allow leaders to identify areas of high demand and waste and allow for examination of the efficacy of conservation and efficiency programs. Proper metrics empower systems as well as leaders. Smart grids, for instance, use two-way electronic communications between the using system and producing system within the grid to allow for an efficient management and distribution of electricity by adjusting loads, costs, and supplies.

Metrics can also enable better acquisitions. By including total energy costs as key performance parameters in acquisition programs, DoD can reduce total energy and energy-related costs over the lifecycle of programs.

Collecting and utilizing appropriate metrics will help the DoD more adequately incentivize energy savings. In the Air Force, for example, for years fuel consumption was tracked administratively by maintenance, but not by the operators who were actually capable of making fuel-saving decisions. Air Force combat flying units were allocated a prescribed number of annual flight hours for flight training based on an estimated cost per hour including fuel. A commander who efficiently trained his aircrews with fewer flight hours than were allocated inevitably scheduled extra sorties toward the end of the fiscal year so as to not be penalized with fewer hours in the subsequent year. This was a disincentive toward efficiencies and energy savings. These and many other similar disincentives need to be realized and eliminated.

*Spend Money Up Front.* President Obama's FY 2010 Defense budget, not including $130 billion of supplemental funding for ongoing overseas operations, is $533.7 billion.[62] The total FY 2011 Defense budget request exceeds $700 billion.[63] The U.S. accounts for 43% of the entire world's total defense spending. America spends more money on defense than the next 14 highest nations combined—nearly five times as much as China and 85 times as much as Iran.[64] The point is, even in a time of a world financial crisis, the DoD budget is massive. Certainly, increased money for advancing efficiency technologies, procuring renewable energies, and research and development will come at the expense of other Defense programs and operations. But given the enormity of the DoD budget, an increase in the already small percentage of the budget spent on renewable energies and technological and operational efficiencies can come at a very modest risk to other programs and operations and could realize great savings for years to come.

The economic stimulus packages have been another source of revenue for DoD sustainable energy and facility efficiency projects. Under the 2009 American Recovery and Reinvestment Act, Congress appropriated to DoD $120 million for Energy Conservation Investment, $4.26 billion for Facilities Sustainment, Restoration, and Modernization, and $300 million for Near Term Energy-Efficient Technologies.[65] These appropriations are welcome, but short-lived and focus mostly on installations. Planning and programming in the DoD baseline budget for energy-related technologies and programs needs to accelerate.

*Advance Research and Development*. The DoD has tremendous research and development resources at its disposal. The Defense Advanced Research Projects Agency (DARPA) has been conducting research in energy-related programs such as high efficiency distributed lighting, systems to convert energy in plastic packaging waste into electricity and/or fuel at forward operating bases, micro generators, advanced solar cells, and surface wave energy harvesting.[66] One potential game-changing technology advance is the possibility of producing synthetic jet fuel from algae. DoD burns more jet fuel than any other fuel type -- about 60 to 75 million barrels per year.[67] Barbara McQuiston, special assistant for energy at DARPA is very excited about the possibilities of algae-based jet fuel: “Being able to get JP8 from a renewable source means you can generate JP8 anywhere in the world independently.” DARPA is seeking to produce a JP-8 jet fuel surrogate that would cost less than $3 per gallon.[68] Algae conversion is showing efficiency that potentially could lead to renewable jet fuel that costs less than $1 per gallon.[69] This type of breakthrough would certainly help lead the way to tactical energy independence.

*Learn from Civilian Industry.* When the next closest military competitor spends about one-fifth as much on defense as the U.S., it is easy to see why our DoD has been complacent and inefficient with respect to energies. In the business world of today, competition is tight, and DoD can learn much from the business practices in the civilian world where waste means an advantage to the competition. Wal-Mart, for instance, saved $26 million and reduced the equivalent greenhouse gas emissions of 18,300 cars last year by simply installing a small auxiliary power unit in each of the cabs in the company's trucking fleet and thereby eliminating hours of engine idling time during rest stops. They are working to double efficiency of their truck fleet by 2015 and thereby save over $200 million annually. They are also testing prototypes that run off of biofuel produced from grease from Wal-Mart's delis.[70]

The airline industry runs on razor-thin profit margins. For years, airlines have taken advantage of Reduced Vertical Separation (RVSM) airspace and efficient GPS-guided approaches to maximize fuel savings. Several of the military's most advanced aircraft lack the equipment required to take advantage of these gas-saving operational advances. But beyond learning from the civilian world, DoD has great opportunities to partner with the civilian industry.

*Leverage Partnerships with Civilian Industry*. Energy is a dual-use commodity with both military and civilian application. Virtually any technology that increases energy efficiencies, any increase in the domestic supply of renewable energy, and any innovation that cuts greenhouse gas emissions will have a strong market in both the military and civilian world. A recent Deloitte study recommends partnerships toward hybrid/electric/biofuel ground vehicles and multiuse generators, solar technologies, engine/propulsion efficiencies, and common biofuels.[71] As the nation's single largest consumer of energy, the DoD creates its own market share and can have enormous clout in advancing technologies that would be welcomed by the civilian world. For instance, low cost and low carbon synthetic jet fuels would be hailed by a civilian airline industry incessantly plagued by high fuel prices and the threat of future oil price spikes and carbon taxes. In 2008, U.S. passenger and cargo airline operations required approximately 449 million barrels of jet fuel.[72] In contrast, the DoD burns about 60 to 75 million barrels of jet fuel per year.[73]

Other partnerships are developing in the use of DoD land for alternative energy production sites. Often solar or wind farm construction is hampered by "not in my backyard" groups who wish to keep energy production facilities and the associated infrastructure and eyesores out of their neighborhoods. The DoD has over 29 million acres of land.[74] Last October, the Army awarded a contract to build a 500 MW solar energy project at Ft Irwin, California--the largest solar facility in DoD. The Fort Irwin project is part of the Army's "Enhanced Use Leasing" program, designed to allow private companies "to acquire and leverage value from under-utilized non-excess real estate assets on Army and select Department of Defense Installations." Private companies deliver services in exchange for lease of military land. The Fort Irwin facility will produce energy well in excess of the base's total electric requirement which will in turn be sold to local utilities.[75] In projects like this, the military, the power company, the nation, and the environment all benefit.

*Change Culture.* Perhaps the most difficult, yet most essential way to holistically affect the way the military acquires and uses energy is through a change in culture. For too long the military and the nation have viewed cheap, abundant energy as a given. The vulnerabilities to national security stemming from our dependency on and use of energies have been largely ignored. Our DoD leadership needs to push this message to civilian leaders outside the DoD. The political leadership of this country needs to fully appreciate the extent of these energy-related threats and strive to change the culture of America from extravagant consumers of energy who are unwittingly threatening national security to “green patriots” who realize their energy choices affect our collective security. When problems are truly recognized to be threats to national security, America takes it seriously. President Eisenhower framed the building of a national highway system as required for national security, and it was built.[76] President Kennedy framed the space race in a similar context, and we went to the moon. DoD could also encourage the political arm to use more than the bully pulpit and presidential-level strategic communications. To change the culture of America our political leaders need to advance complementary legislation that further spurs the growth of renewable energies and efficiency technologies. An example would be increasing the fuel tax. The U.S. has the lowest fuel tax of any industrialized country.[77] Although politically unpopular, a high fuel tax would force a change in the American culture. It would reduce demand for oil, reduce greenhouse gas emissions, and put downward pressure on world market oil prices and correspondingly reduce some of the security costs associated with imported oil.[78]

The DoD leadership should also strive to change the culture of the military to increase energy awareness at all levels. This can be implemented through strategic communication, formal education and training, reorganization, and incentives. As the Air Force's 2010 Energy Plan states, "Energy awareness and cultural change will be achieved when members hold the belief that energy security and energy efficiency are vital to national security."[79] In this energy-aware military culture, "new ideas and methodologies for operating more efficiently will emerge as [servicemen] consider energy in their day-to-day duties."[80] The U.S. military has some of the most intelligent, innovative, creative, and motivated people in the world. DoD leaders need only explain what needs to happen and we are sure to see great advances; for as General George S. Patton Jr. once said, "Never tell people how to do things. Tell them what to do and they will surprise you with their ingenuity."[81]

## Bringing it Together

The Department of Defense has been taking many positive steps to address the concerns of energy use, supply, and effects, yet there is much to be done. The DoD needs to develop, coordinate, and implement a holistic, consistent, and comprehensive energy strategy that simultaneously tackles all these energy-related national security issues.

*What Has Been Done.* Military and civilian leadership have recognized these vulnerabilities and have been taking steps toward a complete energy strategy for years. Most of the DoD energy-related legislative acts and executive orders before 2005 were aimed at facilities and installations—important, but these account for only one quarter of

DoD energy use. In the past few years more attention has been given to operations, fuels, and acquisitions. In September 2005, in response to sharply rising oil prices, President Bush issued a memorandum to all federal agencies to minimize non-essential petroleum fuel consumption. In 2007, President Bush signed Executive Order 13423 setting goals for federal agencies, including DoD, to become more energy efficient and increase use of renewable energies.[82] The Energy Independence and Security Act of 2007 began to tackle both energy independence and climate change as it requires the Defense Energy Support Center to contract for alternative and synthetic mobility fuels so long as they have lifecycle greenhouse gas emissions less than or equal to conventional petroleum.[83] Congress, through the FY 08 National Defense Authorization Act (NDAA), has brought the national security concern about climate change to the forefront by requiring the next national security strategy, national defense strategy, and quadrennial defense review to each include guidance on the effect of projected climate change on current and future DoD missions.[84] In 2008, DoD acquisition directive 5000.2 directed energy costs be included in calculations for total ownership costs, to include the fully burdened cost of fuel.[85] On October 5, 2009, President Obama signed an Executive Order which built upon EO 13423 and the Recovery Act by adding aggressive goals to increase energy efficiency, reduce oil consumption, and use federal purchasing power to increase the speed to market of renewable technologies.[86]

These orders and acts still failed to adequately address the critical requirement needed for a holistic energy strategy – leadership. The FY 2009 NDAA finally directed DoD to create a Director of Operational Energy Plans and Programs with responsibilities to report to congress on issues such as grid vulnerabilities, energy efficiencies, and alternative fuels, and to sculpt DoD's operational energy strategy.[87] On October 28, 2009, the FY 2010 NDAA authorized $5 million to fund the Director of Operational Energy Plans and Programs and expanded the responsibilities of the position.[88] On 12 December, 2009, President Obama finally announced his nomination to this position – Ms. Sharon E. Burke. As of the writing of this paper, the nomination has not been confirmed and the position has yet to be filled.

The individual services within DoD have each attempted to fill the void of a missing DoD comprehensive energy strategy by crafting various energy postures, statements, policies, plans and strategies. Perhaps the most well-articulated paper comes from the DoD's largest user of energy – the U.S. Air Force. The "Air Force Energy Plan, 2010" released in late 2009 by the Assistant Secretary of the Air Force for Installations, Environment and Logistics, does extremely well communicating goals, objectives, and metrics. It states the vision of the Air Force Energy Plan is "to make energy a consideration in all we do." The plan contains three compendium volumes that further tackle energy in aviation operations, acquisition and technology, and infrastructure.[89] This energy plan could serve as a model for the DoD Director of Operational Energy Plans and Programs to build upon when she takes office.

*Way Ahead.* The importance, scale, and complexity of the interrelated energy challenges to our national security are enormous. DoD energy policies need to be informed by an ambitious, overarching strategy that integrates all aspects of DoD energy demand, energy supply, and effects of energy use. It needs to address overall demand for all types of energy, dependence on foreign oil, and reliance on the civilian power grid; it needs to promote development of alternative domestic energies; it needs to seek to reduce the total costs of energy and its use and reduce the logistical trail of operational energy requirements; and it needs to combat the threat multiplier of global climate change. This strategy should reduce demand, assure supplies, and reduce greenhouse gas emissions by collecting appropriate metrics, spending money up front, advancing research and development, learning from and partnering with civilian industry, and changing the culture. This strategy needs to be balanced in terms of near, mid, and long term goals. And this strategy should look beyond its effect on DoD and strive to encourage smart national and global energy policies to increase awareness, actions, technologies, and investments that further contribute to national and world security. America relies on the Department of Defense to provide for the security of nation. It is time for DoD to lead.

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