Strategy Research Project

ENERGY SECURITY AND NATIONAL SECURITY; SECURING U.S. ENERGY RESOURCES

BY

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USAWC CLASS OF 2009

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
19-03-2009	Strategy Research Project	

4. TITLE AND SUBTITLE

Energy Security and National Security; Securing U.S. Energy Resources

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Mr. David Williams

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
COL Michael T. Moon
Department of National Security and Strategy

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army War College
122 Forbes Avenue
Carlisle, PA 17013

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Distribution A: Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

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15. SUBJECT TERMS
National Security, Utility Infrastructure, Alternative Energy

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
UNCLASSIFED	UNCLASSIFED	UNCLASSIFED	UNLIMITED	34	

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TITLE: Energy Security and National Security; Securing U.S. Energy Resources

FORMAT: Strategy Research Project

DATE: 19 March 2009 WORD COUNT: 7,077 PAGES: 34

KEY TERMS: National Security, Utility Infrastructure, Alternative Energy

CLASSIFICATION: Unclassified

The United States has long been dependent on foreign oil and foreign energy sources. The Energy Independence and Security Act of 2007 (EISA 2007) identified multiple areas in which the U.S. should focus in order to become more energy independent. Throughout the course of the historic 2008 Presidential primaries and Presidential campaign, one of the common themes and promises from each candidate was to set a course for the U.S. to achieve energy independence. The U.S. Department of Defense (DOD) continues to look for ways to reduce our dependency on fossil fuels and foreign oil, while at the same time maximizing our energy efficiency and conservation. This paper will look at DOD's energy demand and examine the economic and national security impacts it has on our nation. The paper will also examine renewable energy sources that can be used on DOD installations to create "off the grid" energy capabilities.

ENERGY SECURITY AND NATIONAL SECURITY;
SECURING U.S. ENERGY RESOURCES

Becoming more energy independent improves U.S. energy security. Make no mistake; energy security is one of the most significant strategic challenges facing the U.S. and the world today. With the U.S. currently engaged in two wars in the Middle East and persistent conflict throughout the region, as well as the burgeoning situation throughout the southern region of Africa, we can ill-afford to continue our current level of dependence on foreign energy sources. We must chart a new course in respect to energy. No longer can the amount and cost of energy be an afterthought when developing our military plans and operations or managing our DOD installations. We must undergo an energy metamorphosis. In other words, the DOD must be a leader in increased energy efficiency by developing a holistic approach and comprehensive energy strategy. The DOD energy strategy must not only analyze our usage of conventional energy sources, but also examine the viability of building a sustainable renewable energy portfolio that reduces our dependency on fossil fuels and foreign oil and moves us closer to a “net zero” energy environment.

Throughout the course of the historic 2008 Presidential primaries and Presidential campaign, one of the common themes and promises from each candidate was to set a course for the U.S. to achieve energy independence. On January 8, 2009, less than two weeks before President Obama took office, he spoke about the need for urgency in adopting his reinvestment plan, a part of which calls for billions of dollars to be invested in fixing our energy infrastructure, modernizing federal buildings, and improving energy efficiency throughout the nation. President Obama views his reinvestment plan as a vital step towards meeting our nation’s energy challenges, as

well as a means for jumpstarting and revitalizing our economy. A little more than a year earlier, on December 19, 2007, former President George W. Bush signed into law the Energy Independence and Security Act of 2007 (EISA 2007), which identified multiple areas in which the U.S. should focus in order to become more energy independent.

On May 2, 2006, citing significant risks to both our nation and military forces, the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L) directed the Defense Science Board to convene a task force to analyze the DOD energy strategy. The USD(AT&L) challenged the task force to "find opportunities to reduce DOD's energy demand, identify institutional obstacles to their implementation, and assess their potential commercial and security benefits to the nation."[1] The Task Force study, the most comprehensive DOD energy study since 2001, that DOD faces two primary energy challenges:

- First, "operations suffer from unnecessarily high, and growing, battlespace fuel demand which degrades capability, increases force balance problems, exposes support operations to greater risks than necessary, and increases life-cycle operations and support cost."[2]
- Second, "military installations are almost completely dependent on a fragile and vulnerable commercial power grid, placing critical military and Homeland defense missions at unacceptable risk of extended outages."[3]

These primary challenges undoubtedly show the link between energy security and national security. However, because of the degradation of U.S. utility and energy infrastructure, the increase in demand for oil and other energy resources by countries

like China, India, and Russia, and the under-utilization of alternative energy sources, that link is more exposed than ever before. Therefore, our reliance on foreign oil and fossil fuels must be minimized and we must begin a new energy relationship with alternative energy sources.

Energy Independence and the Economy

How does the U.S. become energy independent and what affect will it have on the economy? It is my belief that in order for the U.S. to become more energy independent, we must first know definitively where we are in respect to relying on outside sources for our energy needs. Secondly, we must evaluate our domestic capabilities and determine how to increase, or at a minimum sustain those capabilities at their current level. Once that determination has been made, then a course of action (COA) or roadmap can be developed to address the issues. However, as stated by Marine Corps General James Jones (Ret) in a December 3, 2008 Wall Street Journal article, "You can't use the word energy independence. It is not a valid phrase. It is designed to excite people. But it is simply not going to happen. However, what the U.S. can do is supply leadership and put our own house in order. We can put technology to greater use and can help developing countries skip the pollution era. It is a big part of the national security portfolio"[4]

As previously stated, to put our house in order we must first determine definitively where we are. On a national level, "the United States is the largest oil importer in the world, bringing in 13.5 million barrels per day (mbd), which accounts for 63.5 percent of total U.S. daily consumption (20.6 mbd)."[5] Seventeen percent of the 13.5 mbd (2.29 mbd) comes from the Middle East, specifically the Persian Gulf, and this dependence is

growing. With the U.S. currently engaged in two wars in the Middle East and persistent instability in the region, the situation is damaging to the economic health of our nation. Also, our dependence on foreign oil, the escalating cost of acquiring that commodity, and less than friendly relationships with many of the oil exporting countries is detrimental to the U.S. trade balance.

"The United States has large assessed volumes of undiscovered oil and gas resources that until recently have been unavailable for exploration and development due to offshore moratoria and onshore access restrictions. The U.S. Minerals Management Service estimates that approximately 18 billion barrels (BBls) of oil and 77 trillion cubic feet (Tcf) of gas in the Outer Continental Shelf have been off limits to industry due to leasing moratoria. In addition, the Coastal Plain of the Arctic National Wildlife refuge remains inaccessible. The undiscovered resource in that area has been assessed by the U.S. Geological Survey at 10.6 billion barrels of oil and 8.6 Tcf of gas."[6]

Obtaining access to these oil and gas resources would not only reduce the amount of oil (13.5 mbd) that we import, but it would also have a significant economic impact. A study commissioned by the American Petroleum Institute (API) showed that developing the offshore areas that had been subject to the Congressional moratoria, as well as the resources in Alaska's Arctic National Wildlife Refuge and a small portion of currently unavailable federal lands in the Rockies, would lift U.S. crude oil production by as much as 2 million barrels per day in 2030, offsetting nearly a fifth of the nation's imports. Natural gas production could increase by 5.34 billion cubic feet per day, or the equivalent of 61 percent of the expected natural gas imports in 2030. In the December

8, 2008 press release, the API stated that “the development of America’s vast domestic oil and natural gas resources that had been kept off-limits by Congress for decades could generate more than $1.7 trillion in government revenue, create thousands of new jobs and enhance the nation’s energy security by significantly boosting domestic production.”[7] “The study also estimates that the development of all U.S. oil and natural gas resources on federal lands could exceed $4 trillion over the life of the resources.”[8]

Federally, the Department of Defense is the largest single consumer of energy in the United States. In 2006, it spent $13.5 billion to buy 110 million barrels of petroleum fuel (about 300,000 barrels of oil each day), and 3.8 billion kWh of electricity. This represents about 0.8% of total U.S. energy consumption and 78% of energy consumption by the Federal government. Buildings and facilities account for about 25% of the Department’s total energy use. DOD occupies over 545,000 facilities and structures worth $600 billion comprising more than 536 installations on more than 29.8 million acres across the globe. In 2007, the Department spent over $3.4 billion for energy to power fixed installations, and just over $10 billion on fuel for combat and combat related systems. These figures exclude energy used by some contractors that performed “outsourced” DOD functions, but are as accurate as current accounting systems permit.

Let‘s examine the primary energy challenges concluded by the DSB in their 2008 Task Force Study and Report.

Primary Energy Challenges Facing the Department of Defense

The two primary energy challenges facing DOD, as noted on the bottom of page 2 and the top of page 3, pose a significant impact to both U.S. national and energy

security. In 2001, a DSB Task Force Report entitled "More Capable Warfighting Through Reduced Fuel Burden" found that "decision makers were not informed about the energy consequences of their decisions, which ultimately determined operational fuel demand, and that high fuel demand compromised operational effectiveness."[9] Based on this finding, the DSB recommended that "DOD re-engineer its business processes to make energy a factor in the key Departmental decisions that establish requirements, shape acquisition programs and set funding priorities."[10] However, seven years later, a February 2008 DSB Task Force Report found that the situations revealed in the 2001 study still exist. This, without question, poses a threat to our national security. In addition, the 2008 DSB Task Force also found the following:

- "Critical national security and Homeland defense missions are at an unacceptably high risk of extended outage from failure of the grid.
- The Department lacks the strategy, policies, metrics, information, and governance structure necessary to properly manage its energy risks.
- There are technologies available now to make DOD systems more energy efficient, but they are undervalued, slowing their implementation and resulting in inadequate future systems and technology (S&T) investments
- There are many opportunities to reduce energy demand by changing wasteful operational practices and procedures.
- Operational risks from fuel disruption require demand-side remedies; mission risks from electricity disruption to installations require both demand- and supply-side remedies."[11]

Based on these findings, the DSB recommended that the DOD do the following:

- "Accelerate efforts to implement energy efficiency Key Performance Parameters (KPPs) and use the Fully Burdened Cost of Fuel (FBCF), to inform all acquisition trades and analyses about their energy consequences, as recommended by the 2001 Task Force.

- Reduce the risk to critical missions at fixed installations from loss of commercial power and other critical national infrastructure.

- Establish a Department-wide strategic plan that establishes measurable goals, achieves the business process changes recommended by the 2001 DSB report and establishes clear responsibility and accountability.

- Invest in energy efficient and alternative energy technologies to a level commensurate with their operational and financial value.

- Identify and exploit near-term opportunities to reduce energy use through policies and incentives that change operational procedures."[12]

To a degree, DOD is addressing some of these recommendations. However, before developing systems or processes to address or implement these recommendations in their totality, we must look more broadly at the overall energy crisis in the U.S. and DOD and determine how we can improve our energy portfolio. Once that determination has been made we can began to assess and develop the methodologies and processes necessary to build sustainable programs that will improve US energy efficiency, reduce our dependency on foreign oil, and recapitalize our critical utility and energy infrastructure. When building these programs, it is important to keep in mind that the fragility and vulnerability of our nation's utility and energy infrastructure pose significant risks to U.S. National Security.

Energy and National Security

The U.S. has a National Security problem, in which the DOD has a unique interest - energy security. Energy is the life-force of the US economy and dependence on imported energy foreshadows a national crisis. "Energy security is a major factor influencing how countries conduct their foreign, economic and international security policies. Major supplier countries with vast energy resources exercise more power on

the international stage than ever before. Energy is a primary consideration in how large importers - in need of adequate, reliable, and affordable supplies of energy - make alliances, offer foreign aid, and otherwise conduct their foreign policy."[13]

The DOD operates in an energy climate that is domestically and internationally uncertain. Therefore, we must consider both short and long-term issues while continuously working to develop enduring energy and utility policies that will provide holistic support to our military forces and installations. Increased competition for energy resources continue to foster rising energy cost. Economically, fuel cost within the DOD accounts for a small fraction of the budget and the concern for fuel supply to support DOD needs, in reality is unfounded. "No DOD fossil-fuel supply shortages are expected in the next 25 years. Although as much oil is projected to be needed in the next 25 years as the total already produced to date, world proven reserves are capable of accommodating this demand." [14] "The issue is not whether DOD will be able to obtain the oil it needs to provide for our national defense, because it will. However, trends in global supply and consumption patterns complicate the logistics challenge of providing fuel to DOD's far-flung operations as well as affecting the price DOD must pay for fuel."[15]

In 2006 the head of the world's largest oil company, Saudi Aramco, said: "We are looking at more than four and a half trillion barrels of potentially recoverable oil. That number translates into 140 years of oil at current rates of consumption, or to put it another way, the world has only consumed about 18 percent of its conventional oil potential. That fact alone should discredit the argument that peak oil is imminent and put our minds at ease concerning future petrol supplies."[16] However, this cannot be

verified and is therefore widely disputed within the oil industry. Also, infrastructure in this and other oil producing countries is dilapidated and continues to deteriorate. Therefore, we must remain diligent in our efforts to reduce our fuel use within DOD, both operationally and on our military installations. This is not only important to operational capability, but also to our overall military readiness. Not doing so, compromises the stability of our fighting force.

For instance, fuel costs represent a large fraction of the 40-50 year life-cycle costs of mobility aircraft and non-nuclear ships. It also "imposes large logistical burdens, operational constraints and liabilities, and vulnerabilities: otherwise capable offensive forces can be countered by attacking more-vulnerable logistical-supply chains. Part of this is because of changes in military doctrine. In the past, we used to talk of the "front line", because we used to talk of the line that was sweeping ahead, leaving relatively safe terrain behind. This is no longer true. The rear is now vulnerable, especially the fuel supply line."[17] So how do we reduce this vulnerability? One way is to better understand and manage the effects of fuel. In their efforts to do just that, "the Army recognized that fuel constitutes a significant portion of the logistics required to flow into the battle area and that by reducing the battlefield-day fuel demand they could improve both force deployment and sustainment."[18] Also, "Army transformation statements recognize the critical warfighting contribution of improved platform and system level efficiency."[19] However, the requirements determination and acquisition decision processes do not quantitatively include it.

The DOD recognized that the effectiveness and efficiency of their combat operations can be greatly enhanced when we develop processes that identify and

account for the fully burdened cost of fuel. "This is because combat and combat related systems are generally inefficient in their use of fuel. This represents a major constraint on the operational effectiveness of U.S. forces and translates directly into poor endurance and persistence in the battlespace. Platforms are forced to use time transiting to fuel sources instead of residing on station, and more of them are needed to maintain a continuous presence. Improvements in the efficiency of platforms therefore would enable U.S. forces to increase their in-theater effectiveness by spending more time on station relative to transit, and by allocating fewer of their assets to sustain a given number at that station.

Platform inefficiency affects operational effectiveness in other ways as well. Moving and protecting fuel through a battlespace requires significant resources. It constrains freedom of movement by combat forces, makes them more vulnerable to attack, and compels them to redirect assets from combat operations to protection of supply lines. Thus, the need to move and protect fuel detracts from combat effectiveness in two ways; by adding to sustainment costs and by diverting and endangering in-theater force capability.

The payoff to DOD from reduced fuel demand in terms of mission effectiveness and human lives is probably greater than for any other energy user in the world. More efficient platforms would enhance range, persistence and endurance. They also would reduce the burden of owning, employing, operating and protecting the people and equipment needed to move and protect fuel from the point of commercial purchase to the point of use. An important implication is that increased energy efficiency of deployed equipment and systems will have a large multiplier effect. Not only will there

be direct savings in fuel cost, but combat effectiveness will be increased and resources otherwise needed for resupply and protection redirected. Truck drivers and convoy protectors can become combat soldiers, increasing combat capability while reducing vulnerabilities caused by extensive convoys. In short, more efficient platforms increase warfighting capability."[20]

Since projections show that the US will grow increasingly dependent on foreign oil sources, despite the implementation of energy efficient technologies and the development of non-fossil fuel energy sources, the DOD must develop processes that incorporate the fully burden costs of fuel for both the warfighting operational platform, as well as all the supporting elements, to include installations.

Installation Energy

DOD installations play a vital role in our effectiveness on the battlefield. "They are a critical component to the Nation's force capabilities and our national defense mission. America's security depends upon defense installation assets that are available when and where needed, and with the right capabilities to support current and future mission requirements."[21] In order to ensure combat effectiveness, DOD installations capabilities must be delivered effectively and efficiently. Building processes and programs that eliminate energy waste and increase energy efficiency on our installations will undoubtedly reduce our dependence on fossil fuels, thus increasing the likelihood of greater combat effectiveness. However, building greater energy efficiency will require us to look beyond the peripheral and penetrate the complexities of our energy challenges so that we can formulate a more comprehensive approach to addressing them.

When we examine the DOD installation, we see that historically its mission has been to provide combat training and when necessary a platform for which to deploy our forces. Although each installation's mission is generally the same, we know that those installations that we deploy our combat forces from have a more critical mission than others and will therefore need to have backup power generation to support that mission in the event of power failure. This backup power is usually based on diesel generators and fuel supplies sized for only short-term commercial outages and seldom properly prioritized to critical loads because those are often wired together with non-essential loads. "DOD's approach to providing power to installations is based on assumptions that commercial power is highly reliable, subject to infrequent and short term outages, and backup can meet demands. Unfortunately, DOD's assumptions about commercial power and other critical infrastructure reliability are no longer valid and DOD must take a more rigorous risk-based approach to assuring adequate power to its critical missions."[22]

Critical missions at DOD installations have expanded significantly in recent years. "During Hurricane Katrina, military installations became central to recovery efforts in three key ways: by serving as the base of operations for relief and rescue missions using military assets; as the central command and control hubs to coordinate the work of other deployed national resources; and as a source of skilled personnel to provide rescue, recovery, medical and other emergency services required by survivors."[23] "Under DOD's new homeland defense mission, military installations would serve a similar function in the event of a terrorist attack on the homeland, becoming operational bases in theater."[24] With these added critical missions, power reliability has

become more important than ever before, thus requiring DOD to reevaluate how it provides power to its installations.

Addressing Vulnerabilities through Utilities Privatization

We operate in a culture where the average citizen thinks only of the cost of the commodity, but rarely if ever thinks of the infrastructure and distribution system by which that commodity is delivered. Whether it's flipping on a light switch, turning up the thermostat or on the water, or flushing the toilet, all that matters is that the lights and heat come on, the water flows from the faucet, and the toilet flushes. Unfortunately, we can no longer afford to operate in that manner. We must make a cultural shift and become more cognizant of the impact of catastrophic failure of our utility infrastructure.

"Because critical infrastructures touch us all, the growing potential for infrastructure problems stems from multiple sources, including system complexity, economic growth, deregulation, terrorism, and even the weather. Electric power systems constitute the fundamental infrastructure of modern society. A successful terrorist attempt to disrupt electricity supplies could have devastating effects on national security, the economy, and every citizen's life. Yet power systems have widely dispersed assets that can never be absolutely defended against a determined attack. Indeed, because of the intimate connections between power systems and society's other infrastructures, we need to consider three different kinds of threats: attacks upon the power system; attacks by the power system; and attacks through the power system"[25] In other words, the system is vulnerable to multi-level or multi-point attacks.

Although we will undoubtedly encounter situations that are caused by circumstances beyond our control, we must identify and assess all probable risks and

take actions to mitigate them. With the added mission responsibilities, it is imperative that DOD addresses the inherent vulnerabilities in its utility infrastructure. The DOD Utility Privatization (UP) Program is one way of addressing current and future utility infrastructure challenges.

Section 2688 of title 10, United States Code, provides the Secretary of a Military Department authority to convey all Defense utility systems, including electric, water, waste water, and natural gas. The Defense Reform Initiative Directive 49 (DRID 49) requires the DOD to privatize all electric, water, wastewater, and natural gas utility distribution systems, except where privatization is uneconomical or where unique security reasons require ownership by the Department. The impetus for exercising this authority, which was reiterated in an April 16, 2008 DOD Utilities Privatization Program update is rooted in the following imperatives:

- "Utility ownership is not a core DOD function
- Missions must be properly supported
- Historically, DOD utilities are underfunded due to competing requirements
- DOD needs industry's best practices, innovations, financing, and economies of scale."[26]

Recognizing that UP is the DOD's preferred tool for providing military installations with utility services at industry standards, the DOD UP program objective is to upgrade all utility distribution systems, where economically viable, capitalizing on industries economies of scale, efficiencies, and best business practices. The DOD UP program, initially scheduled for completion in January 2000, was found to be far more complex

than ever imagined. Because of these complexities, DOD reset the target completion date to September, 2005. Some of the early problems encountered were:

- "Multiple contracting agencies performing pre-award and post award actions
- No standard methodology for conducting economic analyses of proposed utility system conveyances
- No standard methodology for determining fair market value
- No standard methodology for determining Government should cost for the proposed system to be conveyed
- No formal procedure to ensure reliability of actual costs and savings to the government versus anticipated cost and savings in the economic analysis
- No discussions or plan of action to address the impacts of UP conveyances on other utility contracts.
- No discussion or plan of action to address the impacts of UP conveyances on operating budgets of installations at which the conveyances were made
- No discussion or plan of action to address the impact of UP conveyances on installation operating budgets."

"In a May 12, 2005 General Accountability Office (GAO) report to the Subcommittee on Readiness, Committee on Armed Services, House of Representatives entitled Management Issues Requiring Attention in Utilities Privatization, the GAO identified approximately 2600 DOD, water, waste water, electric, and natural gas utility systems valued at about $50 billion."[27] GAO found several areas in which the DOD UP program needed improvements. In respect to those findings, "the DOD outlined a plan of action that was developed in coordination with the DOD military components. This plan called

for immediate actions to fully incorporate the identified improvements in the evaluation process."[28]

The DOD plan also extends the UP program through fiscal year (FY) 2015. By extending the program, the DOD and its military services not only retain a vital mechanism necessary to recapitalize dilapidated utility distribution systems, but also ensures that these systems are transformed to meet the capability requirements of the current and future force . "Economically, in the Army alone from FY1999 through FY2008, the DOD under the authority of 10 U.S.C. 2688 privatized 102 utility distribution systems at a government should cost (net present value) of $6.10 billion, a privatized cost of $4.45 billion and a cost avoidance of $1.65 billion. This accounts for a 27% cost avoidance to the DOD."[29] Operationally, privatized utility distribution systems improve infrastructure reliability and reduce energy usage. However, in order to meet the ever expanding needs of our current and future force, and our country as a whole, we should start using our energy sources here at home and develop a comprehensive renewable energy portfolio. We might also give greater consideration to transitioning to renewable energy as our dominate energy source.

However, if we are to transition, it will not happen easily. "The last major transition occurred in the late 19th century when coal replaced wood as the dominant fuel, meeting 70% of the nation's energy needs. How much renewable energy is needed if it were to replace fossil fuels in the same pattern as coal replaced wood? The United States first consumed as much coal as wood in about 1885. Total energy use then was about 5.6 quadrillion BTU (1 quadrillion = 1015), equal to about 0.19 TW (Terawatts or 1012> watts). Consider what it would take today to replace even just one-

half of U.S. fossil fuel use with renewable energy: we would need to displace coal and petroleum energy flows of 2.9 TW, or 32 times the amount of coal used in 1885. Current global fossil fuel use is about 13 TW, so we need more than 6 TW of renewable energies to replace 50% of all fossil fuels. This is a staggering shift. The only renewable energy that exceeds annual global fossil fuel use is direct solar radiation, which is several orders of magnitudes larger than fossil fuel use. To date however, the delivery of electricity (photovoltaics) or heat (solar thermal) directly from solar energy represents a tiny fraction of our energy portfolio due to economic and technical constraints. Most other renewable energy flows could not meet current energy needs even if they were fully utilized. More importantly, there are important qualitative aspects to solar, wind, and biomass energy that pose unique challenges to their widespread utilization."[30] Still, no matter how challenging it may be, we must move toward renewable energy sources as our dominant energy source.

Renewable Energy

In a November 2008 memorandum to then President-elect Barack Obama, the Institute for 21st Century Energy stated that "we are at a defining moment for our nation's energy future and the United States must now undertake a comprehensive and strategic approach to include both long and short-term actions to address our growing energy challenges."[31] Over the past few years the DOD has been working to do just that. In support of its conventional energy sources, DOD is developing a renewable energy strategy to help combat our energy challenges of tomorrow. "In 2002, funding was set aside by Congress to assess the renewable energy potential of U.S. military installations. The Department of Defense (DOD) created a Renewable Energy

Assessment Team to explore solar, wind and geothermal energy resources at military installations."[32]

"Renewable sources of energy such as wind, solar, energy-from-waste, hydropower, geothermal, and biomass could play an increasingly important role in our nation's energy supply as they continue to become more cost competitive with traditional energy sources. This is especially true for sources that can provide reliable baseload electricity. Hydropower is a proven, long-standing renewable resource. Wind, geothermal, and biomass power are increasingly competitive economically. Energy-from-waste is also proven and used worldwide as a source of clean, baseload power."[33] By developing these renewable energy sources, DOD can work to create off the grid energy capabilities that will help their installations become "net zero". A net zero installation is one that produces as much energy on or near the installation, as it consumes in its buildings and facilities. Using renewable energy sources, along with traditional energy sources, provide military installations a holistic approach to obtaining energy independence.

Wind Energy

Where appropriate, the use of wind energy in conjunction with conventional and other renewable sources offers the U.S. and the DOD military installations an opportunity to decrease our dependency on foreign energy sources. "It is important to note that since the wind does not blow all of the time, it cannot be the only power source without some form of storage system."[34] Although wind doesn't blow all the time and when it does blow, its speed varies; wind power plants increase the probability that conventional utility systems will be able to meet demand requirements. "Wind energy

could supply about 20% of the nation's electricity, according to Battelle Pacific Northwest Laboratory. Wind energy resources useful for generating electricity can be found in nearly every U.S. state. North Dakota alone is theoretically capable (if there were enough transmission capacity) of producing enough wind-generated power to meet more than a fourth of U.S. electricity demand. The theoretical potentials of the windiest states are shown in the following table."[35]

THE TOP TWENTY STATES
for Wind Energy Potential
as measured by annual energy potential in the billions of kWh, factoring in environmental and land use exclusions for wind class of 3 and higher.

	B kWh/Yr		B kWh/Yr
1. North Dakota	1,210	11. Colorado	481
2. Texas	1,190	12. New Mexico	435
3. Kansas	1,070	13. Idaho	73
4. South Dakota	1,030	14. Michigan	65
5. Montana	1,020	15. New York	62
6. Nebraska	868	16. Illinois	61
7. Wyoming	747	17. California	59
8. Oklahoma	725	18. Wisconsin	58
9. Minnesota	657	19. Maine	56
10. Iowa	551	20. Missouri	52

Table 1.

Within the DOD, "there is good potential for wind projects where utility rates are high or where power is generated at remote sites and a wind-diesel hybrid can be developed."[36] "The per-kilowatt capital cost for wind power is about three times that of backup diesel generators. The predictable power supplied by the wind plant results in acceptable payback and a net benefit (over twenty years) of about one and one-half times its incremental investment cost."[37] However, in order for the U.S. and the DOD to

take full advantage of wind potential, a more robust policy must be developed. This policy must not only support more aggressive use of wind energy, but also provide provisions that address the access to, and capabilities of transmission lines.

Solar Energy

"All renewable energy (except tidal and geothermal power), and even the energy in fossil fuels, ultimately comes from the sun. The sun radiates 174,423,000,000,000 kilowatt hours of energy to the earth per hour. In other words, the earth receives 1.74 x 10^{17} watts of power."[38] To meet the world's energy challenges, we must find effective and efficient ways to capture and transfer the sun's power. "Physicists define the word energy as the amount of work a physical system is capable of performing. Energy, accordingly, can neither be created nor consumed or destroyed."[39] However, it can be converted or transferred. Photovoltaic panels and systems is one way to capture, harness, and ultimately convert sunlight directly into electricity. Economically, material and installation cost continue to be an important issue. However, as we increase procurement and usage of solar panels, manufacturers will increase production to meet the demand, thereby creating economies of scale that ultimately reduce costs.

While the DOD Renewable Assessment validates this point, the study also found that "solar PV could be economical where there are very high utility costs, where state and Federal rebates and tax incentives are in effect, and/or where there are state mandates requiring utilities to provide power from PV. The assessment further noted that he best solar potential is in daylighting, transpired heat collection, and solar thermal applications."[40] An example of DOD's use of solar panels is shown below.

The Space and Naval Warfare Command contracted with Northern Power Systems to design and install these portable, highly cold-tolerant runway lighting systems for Antarctic Support Associates, to ensure safe landings for cargo planes on the south polar ice

Figure 1.

Geothermal Energy

Geothermal technology offers the U.S. and DOD an opportunity to reduce our dependency on fossil fuels. It has the potential to provide clean, affordable energy which will diversify our national energy portfolio and increase energy security. Successful geothermal systems require permeability, fluid and heat if they are going to economically produce electricity.

"Historically, geothermal power plants have been built under "ideal" conditions for energy production where heat is close to the surface, the host rock is permeable and porous, the ground has fluid saturation and recharge rates, and where the required elements exist naturally. The relative scarcity of such ideal hydrothermal sites has been a barrier to widespread geothermal energy use."[41] "With geothermal systems, there is

often no need to create mechanical heating or cooling. Instead, ground-source heat pumps use the earth or groundwater as a heat source in the winter and a heat sink in the summer. Geothermal systems often involve a series of pipes, called loops, which are installed below ground or submersed in a pond or lake. In a closed-loop system fluid is pumped into the building where it is compressed in the heat exchanger and released at a higher temperature. In summer this process is reversed, removing heat from the building to cool the facility. In an open loop system, groundwater is piped directly from an aquifer to the building where it transfers its heat to a heat pump. After it leaves the building, the water is pumped back into the same aquifer via a discharge well located a suitable distance from the first."[42]

"The Environmental Protection Agency states that geothermal heat pumps are much more efficient than air source heat pumps because earth temperatures are much more uniform through the year than air temperatures." They also concluded that well-designed and properly installed high efficiency geothermal heat pump systems produce less environmental harm than any other alternative space conditioning technology currently available. On a full fuel cycle basis, emerging geothermal systems are the most efficient technology available, with the lowest CO2 emissions for minimum greenhouse warming impact"[43] Other cost savings and environmental benefits of geothermal are:

Cost Savings Benefits	**Environmental Benefits**
Competitive installation costs	No emissions (no fuel burned)
Lower energy costs by 25-40%	Requires less electricity
Lower water costs	No danger of groundwater contamination
Free domestic hot water in the summer	
Lower maintenance costs	
Utility incentives/rebates	

The DOD Renewable Assessment that was completed in 2005 looked at the use of geothermal technology from two perspectives. "First, it assessed the potential for utility-scale electric power production and second, the direct use of geothermal resources for building heating and cooling systems. The assessment also found that the greatest potential for geothermal development is in sparsely populated areas of the western United States. Most of the military facilities in these areas are used for training exercises that require lots of land, but have little demand for electricity and heating. Also, these facilities are typically far from the utility grid and, as a result, geothermal resources on military lands are generally less attractive for private development."[44]

Biomass

Biomass technology offers DOD a good opportunity to not only reduce our dependency on fossil fuels, but also to reduce global warming. The use of this technology, which uses garbage, animal and plant waste, and other forms of waste to produce electricity or fuels, is becoming more prevalent because of the need to reduce greenhouse gases. If DOD is going to lead the way in reducing U.S. dependence on fossil fuels and improving our energy security, we need to consider this alternative source as a means to help make that happen. "Biomass supplies almost 15-times as much energy in the U.S. as wind and solar power combined."[45]

"In 2006, the Army commissioned Defense Life Sciences, Purdue biomass experts and three other companies to build a prototype refinery. In 2007 they completed two 4-ton biomass refineries designed to turn piles of trash into electricity. Each can run for 20 hours on a ton of trash, producing enough power to light a small village. This technology was deployed to Iraq and will replace encampment generators

which will mean fewer trips into harm's way for Soldiers who drive tanker trucks. About 10 percent of the electricity the refineries produce is used for the machines' power needs, the remaining 90 percent would be available for the troops to use. It will also free up more fuel for tanks, Humvees and other military equipment."[46] The Army has selected six sites for biomass/waste-to-energy demonstrations through a contract with the Defense Logistics Agency (DLA). This is an example of how the DOD can apply renewable sources of energy in the future.

Recommendations

Improve energy security by developing a comprehensive energy program that combines conventional and renewable technologies that eliminate waste and increase energy efficiency across platforms and facilities. The energy situation throughout the world continues to be a conundrum. The debate over oil supplies rages on. Whether proven reserves are an accurate depiction of future supply or not, it is incumbent upon us to do all we can to improve our energy security by reducing our dependency on foreign oil and fossil fuels. "Whether it is increasing platform efficiency by revising current policies to incorporate delivered cost of fuel in acquisition decisions, accelerating installation initiatives by expanding the Energy Conservation Investment Program (ECIP) or Energy Savings Performance Contracts Program (ESPC), or establishing an alternative fuels program that develops an incentive program for the alternative fuel industry, the DOD is doing just that."[47] Another example within the DOD where this is taking place is the Army. Under the direction of the Deputy Assistant Secretary of the Army for Energy and Partnerships, the Army developed an Army Energy Security Implementation Strategy that requires them to "raise the energy

efficiency for generation, distribution, storage and end-use of electricity and fuel for system platforms, facilities, units and individual Soldiers and Civilians. This goal also relates to the productivity of a system based on energy requirements and supports the ability to make informed trade-offs in development, engineering and deployment of weapon systems."[48]

Increase use of renewable energy sources. Although there are enough conventional sources to support the DOD's needs for the next 25 years, in order to meet future challenges and reduce the cost associated with those challenges, we must reduce our energy consumption and improve our energy efficiency across our installations. "For instance, the Army spends over $3 billion every year on energy and the majority of it is spent on its installations. Energy consumption can be significantly reduced by partnering within government and with the private sector to capitalize on the great strides in proven technology that have been developed and implemented across the country. The Army plans to increase efficiency and serve as a model for the military and the nation when it comes to the operation of its housing, buildings, and forward operating bases. By making greater use of alternative and renewable energy, Army initiatives will bring energy savings and security to the Army, reducing the risk of power disruption. The Army has several pilot projects underway. The Army will partner with the private sector to construct a 500 megawatt solar thermal plant at Fort Irwin, Calif, in the Mojave Desert, that will provide renewable power on the grid and provide the sprawling Army post with added energy security against disruption of power supply. The Army is pursuing the purchase of 4,000 small Neighborhood Electric Vehicles to replace gasoline-powered vehicles traditionally used by maintenance and operations

staff for use on its posts. Six Army posts have been selected as sites for biomass to fuel demonstrations through a contract with the DLA. Also the Army is working with the private sector and with the Navy to develop a major geothermal project at Hawthorne Army Depot, Nev., with the capability of producing 30 megawatts of clean power."[49]

Conclusion

Energy security and reducing our dependency on foreign oil and fossil fuels without a doubt is a major concern nationally, federally, and within DOD. "Not since the 1970s has America's national security been so threatened by its energy insecurity, and, as we have learned the hard way over the past seven years, achieving energy security in the 21st century requires far more than simply expending our economic and political resources to keep oil flowing steadily out of unstable and even hostile countries and regions. Every president since Richard Nixon has spoken to the nation about how oil addiction is jeopardizing our national security. President Obama is no different and has identified it as one of the top three issues facing the U.S. today, thereby making it one of the key initiatives of his administration.

As the largest consumer of electricity, the federal government must lead the way in promoting energy efficiency and reducing energy consumption. Building a comprehensive energy portfolio that uses both conventional and renewable technologies will put us on a path to meet this challenge. President Obama's energy plan calls upon the federal government to ensure that all new federal buildings are zero emissions by 2025, and to help reach that goal he will ensure that all new federal buildings are 40 percent more efficient within the next five years. He also will place retrofitting existing federal buildings as a top priority and seeks to improve their

efficiency by 25 percent within 5 years. His plan calls for an increase in fuel economy standards, investing in developing advanced vehicles, investing in a digital smart grid, investing in key technology development and using more renewable technology such as wind, solar, geothermal."[50]

Whether or not we will successfully meet the requirements of President Obama's energy plan or any future energy plan remains to be seen. Although in my estimation true energy independence is not achievable, it is imperative that we strive to become as close to being energy independent as possible by taking a holistic and comprehensive approach, using both conventional and renewable energy sources.

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