Improving Transportation by Leveraging Alternative Energy Solutions: Initiatives in U.S. Air Force Transportation Systems

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ABSTRACT: Efficient transportation of material, people, and other resources is a key factor in any successful military campaign. Leveraging alternative fuels presents an exceptional opportunity for the Department of Defense (DoD) to address one of the most significant issues it faces as it strives to improve its transportation and logistics. Effectively managing the availability and cost of fuel, or aptly put "fueling the fight" could literally dictate ultimate success or failure on the battle field. This paper will examine the issue, identify some of the laws and directives that address energy consumption, describe the United States Air Force's (USAF) and the United States Air Force Academy's (USAFA) responses to the situation. A review of alternative energy solutions being studied and implemented by USAF transportation systems includes a case study on biodiesel; the alternative energy source that has an immediate potential impact on transportation for USAF organizations.

Key Words: transportation, energy, fuel, biodiesel

Improving Transportation by Leveraging Alternative Energy Solutions:

Initiatives in U.S. Air Force Transportation Systems

"At the end of this decade… the United States will not be dependent on any other country for the energy we need to provide our jobs, to heat our homes, and to keep our transportation moving."

President Richard M. Nixon, January 30, 1974—State of the Union Address
(*Collected State of the Union Addresses of U.S. Presidents: Richard Nixon,* 1974)

Overview:

Recognizing and addressing energy's impact on the basic transportation needs of our citizens has been the focus of recent Administrations. But nowhere are the potential negative impacts as keenly felt, or as closely monitored, as they are in the daily operations of the Department of Defense (DoD). Efficient transportation of material, people, and other resources is a key factor in any successful military campaign. The age-old adage that "an army moves on its stomach" is as true today as it was when Napoleon Bonaparte allegedly said it over 150 years ago.

Leveraging alternative fuels presents an exceptional opportunity for the DoD to address one of the most significant issues it faces as it strives to improve its transportation and logistics. Effectively managing the availability and cost of fuel, or aptly put "fueling the fight," could literally dictate ultimate success or failure on the battle field. This paper will examine the problem, identify some of the laws and directives that address energy, describe the United States Air Force's (USAF) and the United States Air Force Academy's (USAFA) responses to the situation, and review alternative energy solutions being studied and implemented by USAF transportation

systems including a case study on biodiesel; the alternative energy source that has an immediate potential impact on transportation for USAF organizations.

Addressing the Problem:

The USAF has become particularly sensitive to energy issues related to transportation as the landscape of global conflict has transformed from a two super-power stand-off, into the multi-theater unconventional environment commonly referred to as the Global War on Terror (GWOT) or Overseas Contingency Operations (OCO). The USAF, while serving as a front-line combatant and as a key link in the logistic-chain of an increasing agile and multi-front war-fighting machine, has become the nation's single largest user of petroleum products. In Fiscal Year (FY) 2006, it consumed over 7 million gallons of aviation fuel each day (2.6 billion gallons per year) with charges being of $5.7 billion (United States Air Force Energy Program: Aviation Operations and Fuel Initiatives, 2007). In comparison, the US Coast Guard spent $166 million in FY 2006 (Gore, 2007). The USAF also consumes about 77 trillion British thermal units (BTU) to operate its facilities at an annual cost of more than $945 million (United States Air Force Renewable Energy Program, 2007).

But as vast as this incredible amount of energy consumption might appear, it must be put into the relative perspective with the immense size and resource consumption of the entire DoD and its armed services. In fact, it is the single largest consumer of energy in the world. With its 187,493 non-tactical vehicles that consume 97 million gasoline gallon equivalents, and with its worldwide operations containing an estimated 577,000 buildings, consuming 1,100 trillion BTUs, it consumes roughly 10 times more (per

capita) then the energy consumption in China (Karbuz, 2007). Put into dollar terms, in 2006, the Defense Energy Support Center (DESC), the clearing house for DoD fuels management, sold more than $12 billion of energy to DoD (Scheina, 2008).

With this perspective, it is readily apparent why conservation and transportation efficiency imperatives have been focused on energy consumption. With Executive Branch-level direction, a changing operational landscape, conspicuous consumption of energy, and an increasingly dynamic cost environment, the USAF is faced with few options other than to pursue the development of innovative technologies and alternative fuels. This is especially true in relation to its transportation needs. Some argue that bio-fuels and other synthetic fuels show the most promise for immediate impact. These alternative fuels also offer incredible opportunities for public-private partnerships. Of particular interest to public administrators in the transportation sector is the interaction between these military sponsored technologies and the related civil and commercial sectors. History has shown that technology developed in the DoD often flows quickly to the commercial sectors and other public entities transforming industries and even entire economies.

Executive Orders and Initiatives

Leveraging alternative energy is not an option; it is top-level direction. Over the years, various Executive Orders have commanded the USAF to increase efficiency in the transportation of military resources while emphasizing the imperative to reduce the nation's dependency on foreign energy. Bio-diesel specifically supports the wide-range of different Executive Orders and direction set forth by the President, DoD, and USAF

through direction and policies including efficiency-oriented initiatives such as Air Force Smart Operations for the 21st Century (AFSO 21).

Some believe that modern energy program for the federal government began in 1975 with enactment of the Energy Policy and Conservation Act (EPCA). In addition to creating the Strategic Petroleum Reserve, this law required federal agencies to reduce energy consumption by 20 percent by 1985 (Energy Policy and Conservation Act of 1975, as Amended, 1996).

Other major legislation passed over the last few years have continued to highlight energy management and transportation issues specifically. In 2005, the Energy Policy Act (EPAct) levied energy reduction goals of 2 percent per year for the next 8 years. (Energy Policy Act of 2005, 2005). For many federal agencies, transportations costs where the most likely targets for reduction and improvement efforts. For example, aviation fuel use, (which comprises 81 percent of the Air Force energy budget) is aggressively being addressed to meet the reduction goals associated EPAct (United States Air Force 2008 Infrastructure Energy Strategic Plan, 2008).

On January 24, 2007, President Bush signed Executive Order 13423, "Strengthening Federal Environmental, Energy, and Transportation Management." In addition to increasing energy reduction goals to 3 percent a year, this Executive Order required government installations to develop an environmental management system, or EMS, which is a formal framework for integrating the consideration of environmental issues into the overall management structure and to improve energy efficiency (Executive Order 13423, 2007). Additional transportation related provisions require agencies to also improve energy efficiency and reduce greenhouse gas emissions, ensure that at least half

of the energy consumed by the agency in a fiscal year comes from renewable sources, reduce toxic waste, and prescribed reductions in oil use if the agency operated a fleet of at least 20 motor vehicles (Executive Order 13423, 2007).

The Energy Independence and Security Act (EISA) of 2007 levied additional requirements including the necessity for building energy audits (25 percent of covered facilities per year), reduction of fossil-fuel generated energy consumption starting with 55 percent in 2010 continuing to 100 percent by 2030 (Energy Independence and Security Act of 2007, 2007). Among a long list of other requirements, this law also stated that new and existing facilities can generate no less than 30 percent of hot water requirements through solar heating (where life-cycle cost effective) and agency self-certification of green construction with 5 percent of Agency facilities externally certified annually (Energy Independence and Security Act of 2007, 2007). Recently, a memorandum on EISA prescribed an annual fuel economy increase for automobiles to achieve an average fuel economy of 35 miles per gallon by the year 2020 (Memorandum on the Energy Independence and Security Act of 2007, 2009).

The Advanced Energy Initiative, which aimed to break America's dependence on foreign sources of energy, was announced in President Bush's State of the Union Address on January 31, 2006. It encourages research into two main trusts: changing the way we fuel our vehicles and changing the way we power our homes and business. It set the stage for a national goal of replacing more than 75 percent of U.S. oil imports from the Middle East by 2025 by employing existing technologies and accelerating future technologies (National Economic Council, 2006). In turn, the DoD set its own goals and developed an aggressive energy agenda. An amendment to the 2006 DoD Authorization

Bill set a goal for the department to convert 25 percent of its electronic resources to renewable energy sources by 2025. In 2006, only 8 percent of DoD's electricity came from renewable energy (Scheina, 2008), even with the USAF alone purchasing over 990 gigawatt-hours; or enough to power over 100,000 medium sized homes (United States Air Force Energy Program: Renewable Energy Initiatives, 2007).

In light of these laws and initiatives, many DoD locations are trying to bring energy efficient practices to reality. For example, Nellis Air Force Base in Nevada recently built a "Sun Park" Photovoltaic Power Project that allows the base to take advantage of the sunny Nevada days by converting solar rays to energy. Its 72,000 panels producing 30.1 million kilowatt-hours per year is the largest solar power plant in the United States (Peters, 2008). Also, Sandia National Laboratories and Kirtland Air Force Base are sharing a wind farm that will provide as much as one-third of the electricity used by the two entities (Burroughs, 2008).

USAF Response:

The USAF is the most powerful, effective, and capable Air Force in the world; but it faces a challenging future in light of an uncertain energy environment. The USAF must continue to adapt and improve it processes to meet available resources, or its ability to accomplish its mission could be placed in jeopardy. Some argue that our current energy posture increases the risk to our national security. The USAF strategic response to the current energy challenges was the creation of the 2008 Infrastructure Energy Strategic Plan. The position of USAF leadership was that they needed a purposeful campaign that built upon its long history of energy conservation to create an enduring and

viable energy strategy that addressed conservation mandates, established energy independence, and provided the path to acquire the resources necessary to make its installations energy efficient (United States Air Force 2008 Infrastructure Energy Strategic Plan, 2008).

USAF energy strategy is comprehensive and addresses the full-spectrum of energy activities including reducing consumption to diversifying supply through the use of renewable energy alternatives. The plan was developed upon four pillars: 1) Improve Current Infrastructure; 2) Improve Future Infrastructure; 3) Expand Renewables; and 4) Manage Cost. The pillars rest upon "enablers" such as our planning, programming, and budgeting (United States Air Force 2008 Infrastructure Energy Strategic Plan, 2008). Throughout this process, energy awareness is highlighted to ensure that technology improvements in the private sector are integrated effectively and create a meaningful change in USAF culture. Once innovative ideas and process improvements are identified, they must be substantiated before implementation. Ideally a goal-driven strategic campaign, that is a comprehensive and strategic approach to continuously improving work processes, will provide the USAF with the means to reduce consumption and allow for mission accomplishment within any constrained resource environment.

The initial results, especially in transportation related initiatives, have been impressive. As an example, a B1-B Lancer bomber became the first USAF aircraft to fly at supersonic speed using alternative fuels (Bates, 2008). The USAF Alternative Fuels certification offices states that their goal is to have every aircraft using synthetic fuels by 2011 and by 2016, 50 percent of this fuel will be produced domestically (Bates, 2008).

The USAF approach to this daunting challenge was to tap directly into the ideas and innovation of its members. The creation of the Air Force Smart Operations for the 21st Century (AFSO 21) Office provided a framework for making documented suggestions and informed choices. From an operational perspective, the overall intent of AFSO 21 is to efficiently deliver capabilities to front-line commanders, while also seeking effectiveness in non-combat operations. With its members all attempting to continually improving their performance and capabilities, the desired effects of productivity, resource availability, agility, safety, and energy efficiency were expected to emerge. The AFSO 21 Office, created in February 2006, looks at process improvement across the entire USAF (Fiato, 2007). The office provides top-level guidance for implementing AFSO 21 initiatives. The former Director of the AFSO 21 Office once said, "These initiatives will enhance a mindset in the Air Force that is already geared toward innovation…the Air Force has always fostered a culture of innovation. We are trying to take that culture of innovation to the next level, where we look at all the processes involved in what we do" (Lopez, 2006).

AFSO 21 uses tools and techniques to seek and attack problems and identify opportunities for improvement. AFSO 21 applied across organizational, functional, and capability boundaries results in processes that are more effective and responsive in meeting operational objectives. AFSO 21 signifies a shift in USAF thinking which allows it to gain insights into the value, or lack of value, in each task performed and is built on successful principles from the corporate world (Posner & Ritter, 2006). Identifying opportunities to improve transportation by leveraging alternative energy solutions is in lock-step with the AFSO 21 philosophies.

Review of Air Force Alternative Energy Solutions

Synthetic Fuels

Two central imperatives drive the USAF push towards utilizing synthetic fuels and both of them directly impact transportation. The first imperative simply involves the cost of fueling the nearly 6,000 aircraft in service. Given the Air Force consumes the majority of fuel used by the U.S. military, around $6 billion per year, a huge fiscal incentive exists to abandon high priced fuels (United States Air Force Energy Program: Aviation Operations and Fuel Initiatives, 2007)**.** The second imperative aims to reduce dependency on a foreign import in a volatile global market. Many of the world's leading petroleum exporters have potentially adverse relationships with the U.S. The possibility of these foreign countries engaging in political power struggles over access to, and pricing of, crude oil may threaten national security (Kopp, 2008).

The USAF has already taken the initial steps in certifying the entire fleet for synthetic fuels. With multi-million dollar equipment, they realized the necessity of extensive testing and precaution. The first aircraft to undergo certification tests was the B-52 in 2006 at Edwards AFB, CA. The eight engine aircraft allowed the necessary risk mitigation techniques. First, only one engine operated on 50/50 synthetic blend, then two, and so on until all eight engines burned the synthetic blend (Wasef, 2008). Robins AFB, GA, is the home to the Air Force Advanced Power Technology Office where the USAF conducts research on synthetic fuel for use in a ground environment. Mike Mead, head of the Air Force Advanced Power Technology Office, said, "Currently

we are demonstrating both a 100 percent synthetic fuel and a 50/50 blend of synthetic and petroleum fuel for vehicles and ground equipment applications" (Houseman, 2006). An advantage to using these synthetic fuels, discovered through the research, is that synthetic fuels are actually "cleaner" than regular fuel. An alternative that is 100 percent synthetic fuel produces no visible smoke when combusted and the 50/50 blend produces only a slight amount (Houseman, 2006).

Wind Energy Initiatives

As the USAF continues to seek alternative methods to "fuel the fight", they are also very interested in reducing their carbon footprint and consequently more bases are also turning to wind energy. While this relatively immature energy source is still expensive, the attractiveness is its flexibility. Wind turbines can capture energy almost anywhere because the larger turbines can tower upwards of 250 feet into the sky. However, creative thinking and innovative implementation are constantly improving turbine technology.

The USAF has undertaken wind energy initiatives at several bases in the contiguous United States. over the past decade. These initiatives relate mostly to purchasing wind energy from local suppliers that also bolsters the wind-energy industry. However, projects to build wind turbines to produce the electricity also exist. Several USAF bases purchase wind energy to supplement their electricity needs. For example: Edwards AFB in California buys enough wind power to supplement 60 percent of its needs; Ellsworth AFB in South Dakota purchases all output from a local 750 kilowatt-

hour wind turbine; Fairchild AFB in Washington purchases green power, mainly wind power, to cover 100 percent of its needs; and Goodfellow AFB, Hill AFB, Laughlin AFB, Minot AFB, and Sheppard AFB all cover a significant portion of their energy needs by purchasing wind power (Green Power Partnership: Partner Profile, 2009).

Solar Energy Initiatives

Another alternative energy source that is being investigated to augment the DoD's high energy consumption needs is solar energy. The Air Force operates and maintains over 616 million square feet of facilities at 166 major and minor installations around the world (United States Air Force Energy Program: Renewable Energy Initiatives, 2007). With such a large footprint, solar power has been considered an attractive energy source for many years, albeit not a solution to USAF energy needs. Whether acquiring green energy by building its own solar farms, or purchasing solar derived energy from a non-DoD power supplier, the USAF has demonstrated a commitment to this alternative energy initiative. The benefits also manifest themselves by being environmentally friendly and attractive for public-private sector partnerships.

There are many major success stories. As mentioned earlier, the USAF undertook a much more massive solar energy project at Nellis AFB in Nevada. The project began construction in 2007 and was completed in six months. The solar farm covers nearly 140 acres of land on Nellis and consists of over 70,000 solar panels (Richard, 2007). The units of solar panels are called "trackers" because they track the sun throughout the day. By tracking the movement of the sun, the panels can gather roughly 30 percent more than

fixed systems. The solar power will cut base energy costs by roughly $83 thousand each month, amounting to annual savings of $1 million (Richard, 2007). But a facility does not have to be located in the desert to capitalize on solar energy. Tenants at Eielson Air Force Base in Alaska are replacing propane units with solar power even though the sun often shines less than four hours a day (Snyder, 2009).

Nuclear Power

While literally dozens of other alternative energy initiatives are being pursued by the USAF, including everything from biomass to wave energy, none are as controversial as a proposal dealing with nuclear power as an alternative energy source. Even though there are over 100 operating plants in 31 states that produce about one-fifth of America's total energy consumption; and even considering the fact that it is relatively clean and inexpensive (after construction) at about 1.8 cents per kilowatt-hour, the real and emotional risks associated with this alternative fuel is palpable (National Economic Council, 2006).

A proposal has been suggested that includes installing a small, self-contained, subterranean nuclear reactor at one or more installations to provide virtually unlimited secure power. Even though this option would free-up incredible amounts of energy that could be used for transportation and other uses, it faces some obvious hurdles since the technology is not readily commercially available and there are a host of complex technical and regulatory questions (Peters, 2008). The concept calls for the reactors to essentially operate like buried batteries producing power until the fuel was depleted, after which a contractor would replace the reactor with a new one, returning the depleted

reactor to a factory for refueling (Peters, 2008). The USAF would not be dealing with nuclear waste which makes this option economically more feasible.

Obvious "not-in-my-backyard" objections by the public would tarnish the attractiveness of this alternative fuel as well. But an independent power generating capability by the year 2018, would significantly reduce the vulnerability of USAF installations to commercial power grid failures. This is something the DoD has been advocating over the last few years and they are considering building a small nuclear reactor (Weinberger, 2009).

USAF Academy's Response

From this broader USAF context, at the base or institutional level, the Superintendent of the USAFA established the aggressive goal of turning the base into a "Net Zero" installation by 2015. Simply put, his goal was to produce as much electrical energy from renewable sources as the installation consumes; roughly 107 megawatt-hours in 2007 at a cost of about $6 million (Van Winkle & Imada, 2009). If realized, USAFA would vault to a world leadership position in the application of renewable energy. To achieve this goal, USAFA drafted its Energy Strategic Plan. In addition to a strong focus of achieving "Net Zero" electricity usage by the end of calendar year 2015, the plan called for elimination of USAFA's carbon footprint from facility and transportation sources by 2025. This unprecedented goal is to be achieved via a notional approach involving an expected mix of relatively mature alternative energy technologies; solar generation, wind, solar thermal, biomass, hydroelectric, waste-to-energy, bio-diesel and conservation (Roeder, 2009).

In a huge step toward accomplishing the ambitious Net Zero Initiative, $18.3 million was earmarked for USAFA from the recently passed American Recovery and Reinvestment Act, better known as the economic stimulus bill. The money will fund a new energy contract between USAFA and Colorado Springs Utilities to procure and operate a 10-24 acre, 4-megawatt solar plant that will provide a cost savings of more than $600 thousand per year (Van Winkle & Imada, 2009).

Also enabling USAFA to achieve its Net Zero goal are activities such as the use of converted fry-oil into bio-diesel which could dramatically reduce the cost of transportation while eliminating the current cost of disposal. We will use this bio-diesel aspect of USAFA's Net Zero Initiative to describe how we leveraged conserving energy and improving transportation into a learning experience for our students.

The Management Department's Response

From an academic perspective, the Department of Management at USAFA determined that supporting the Net Zero Initiative could also be directly applied to accomplishing its mission by identifying aspects which could be excellent cadet learning experiences. The key to success was developing learning outcomes and structuring an academic exercise that challenged cadets to approach the "problem" with appropriate tools and techniques, while demonstrating sound problem-solving acumen. They were tasked to justify which alternative energy approaches were cost effective and realistic using a portfolio of Systems Engineering Management and Technology Innovation tools including feasibility analysis and venture analysis. Further, they were required to

determine more subjective criteria such as whether alternatives directly or indirectly help reduce our dependency on foreign oil.

The specific purpose of the exercise was to justify developing an innovative proposal to convert fry oil (renewable fat) waste into bio-diesel fuel. USAFA has the largest fry oil trap in the USAF next to the cadet dining facility. Using current technologies, it was purposed that a large scale plant could potentially be built to convert this renewable fat into diesel fuel to meet base transportation needs. This same concept is being embraced by universities across the nation. For example, Colorado State University in Fort Collins, CO, "sells" enough waste cooking oil from its residence halls' dining facilities to produce 2,520 gallons of biodiesel (Woods, 2008).

Another goal of the project was to study the implementation of a large scale bio-diesel project that potentially could be used as a prototype for other bases to emulate as well as the development of a ruggedized deployable unit for operational and even combat locations. This bio-diesel project will meet stated "green" sustainability goals and is aligned with USAFA's institutional mission and objectives while it facilitates cadet exposure to alternative energy solutions. After an approach was justified, a pilot test of an actual small-scale plant and associated processes was conducted with commercially procured equipment.

Management Capstone cadets conducted a business case analysis (BCA) to explore converting used cooking oil from Mitchell Hall - the USAF's largest grease trap - and convert it into useable bio-diesel fuel for use in installation vehicles. In early 2009, the project received more than $30,000 in funding from the Department of Homeland

Security's (DHS) USAFA Center for Disruptive Innovation to purchase a 30-gallon bio-diesel reactor and begin research (Van Winkle & Imada, 2009).

The possibilities for spin-off commercial products, including glycerin-based soap, have been identified from the bi-products of producing the bio-diesel fuel. These venturing opportunities will be studied by groups of future cadets to determine feasibility.

Case Study: Bio-diesel

In alignment with USAF Academy's Net-Zero Initiative, specifically oriented toward improving transportation, and as an integral part of a sequence of senior-level capstone courses, a feasibility study and venturing analysis was performed on the concept of a bio-diesel plant at USAFA for on-base production and use of bio-diesel. These tasks were performed over a two years period by first class (senior) cadets who were majoring in Management or Systems Engineering Management. The cadets were enrolled in the two course sequence: MGT 419/420, Technology Innovations Management and Systems Research and Development Management. After two years of study and research, the cadets determined that an on-base bio-diesel production plant was technically, financially, and commercially feasible.

To arrive at this conclusion, credible cost analysis and documentation is required. However, just as they will experience in the "real world", there is no single correct approach or predetermined checklist. Cadets working on this specific project took various trips to alternative energy corporations, conferences, and universities to gather supporting data. The USAFA Innovations Center, sponsored in part by the Department of Homeland Security (DHS), became the primary source of funding for these activities. This support eventually facilitated the purchase of a small pilot conversion system for

initial testing and production of bio-diesel in cooperation with the USAFA's Chemistry Department.

In the USAF, regardless of the relative amount of money involved, justifying the authorization to purchase hardware requires considerable documentation. In the exact format that is directed and required in the "real" USAF, the cadets were challenged to create a feasibility analysis in the form of a USAF Business Case Analysis (BCA). If successful, this BCA could also be used as a prototype for other bases to emulate as they study the feasibility of implementing other alternative energy sources. It could also be used to validate the feasibility of variants including the development of a ruggedized deployable bio-diesel unit and the feasibility of commercial applications of the glycerin bi-product.

According to the cadet's BCA, with the waste fry-oil reserves available on the base and utilizing an 80-gallon bio-diesel conversion system, USAFA could save approximately $400 thousand over a ten year period. By converting the waste fry-oil into bio-diesel from all of the dining facilities on the installation, USAFA could improve its transportation processes by potentially reducing petroleum consumption by 2 percent per year, meeting provisions outlined in Executive Order 13423. The project also met stated "green" sustainability goals and was aligned with USAFA's Net Zero Initiative. Bio-diesel implementation, as proposed, also supported other Executive Orders, DoD, and AF Policies including AFSO 21.

Cadets decided to purchase the small conversion system through research and recommendations from the alternative energy community. However, further market analysis would be required in order to determine the best 80-gallon conversion system

that would optimally meet USAFA's needs. Cadets were invited to bench-mark on-going operations at an alternative energy research and development laboratory at Tyndall AFB, FL were a large-scale bio-diesel conversion system is already in use. This project provides an example of how top-level laws and directives have been leveraged through inter-agency cooperation. The result was an improvement to transportation and an excellent learning opportunity for cadets.

Summary and Conclusions

The difficulties associated with "fueling the fight" will not simply go away for the USAF. Transportation needs will increase as GWOT and OCOs demand that our armed forces face the enemies in literally every corner of the world. As energy consumption continues to increase, funding and availability issues have the potential to impact USAF's mission. The implications of this is staggering and to prevent it, the government has enacted several laws and directives all aimed at increasing efficiency, encouraging the use of alternative fuels, and enabling innovation to address the problems associated with energy. Increased use of alternative fuels will reduce our dependency on foreign oil while setting an excellent example for other DoD and federal agencies.

USAF has answered this call to arms with bold energy initiatives. USAFA in particular, has also stepped-up to the responsibilities of preparing future officers to better address the issues by inculcating the topic of energy consumption directly into the classroom. Alternative fuels, including bio-diesel, not only offer immediate positive impact on transportation requirements, but they also promise incredible opportunities for public-private partnerships. Historically when the DoD sponsors technology mega-

projects; civil and commercial innovation often follows. One needs to look no further than the transformation of the military ARPAnet into the ubiquitous Internet, to see the potential impact of this type innovation has on our everyday life. As this type of innovation and technology flows from the DoD to the commercial sectors, industries and even entire economies can be transformed. Perhaps embracing alternative fuels could be leveraged to create the same type of synergy.

*Opinions, conclusions and recommendations expressed or implied within are solely those of the authors and do not necessarily represent the views of USAFA, USAF, the DoD or any other government agency***.**

Bibliography

Bates, M. (2008, March 20). *B-1B achieves first supersonic flight using synthetic fuel blend*. Retrieved March 6, 2009, from http://www.af.mil/news/story.asp?id=123090913

Burroughs, C. (2008, May 20). *Wind farm may be on the way for Sandia, Kirtland Air Force Base*. Retrieved March 6, 2009, from Sandia National Laboratories: http://www.sandia.gov/news/resources/releases/2008/windfarm.html

Collected State of the Union Addresses of U.S. Presidents: Richard Nixon (1974, Janurary 30). Retrieved March 6, 2009, from http://www.infoplease.com/t/hist/state-of-the-union/187.html

Energy Independence and Security Act of 2007, Pub. L. 110-140. (2007). Retrieved March 6, 2009, from http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_public_laws&docid=f:publ140.110.pdf

Energy Policy Act of 2005, Pub. L. 109-58. (2005, August 8). Retrieved March 6, 2009, from http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=109_cong_public_laws&docid=f:publ058.109.pdf

Energy Policy and Conservation Act of 1975, Pub. L. 94–163, as Amended. (1996, May 15). Retrieved March 6, 2009, from http://www.gpo.gov/fdsys/pkg/CRPT-104srpt273/pdf/CRPT-104srpt273.pdf

Executive Order 13423. (2007, January 24). *Strengthening federal environmental, energy, and transportation management.* 72 Fed. Reg. 3919. Retirieved March 6, 2009, from http://www.ofee.gov/eo/EO_13423.pdf

Fiato, K. A. (2007). AFSO 21: A case study in process improvement. *Air Force Journal of Logistics*, XXXI (3), 30-37.

Gore, D. (2007, Fall). Thinking green: Why energy management should be important to military comptrollers. *Armed Forces Comptroller*, 52(4), 36-39.

Green Power Partnership: Partner Profile. (2009, March 2). Retrieved March 6, 2009, from http://www.epa.gov/greenpower/partners/partners/usairforce.htm

Houseman, D. (2006, October 5). *Technology office tests synthetic fuel in ground vehicles*. Retrieved March 6, 2009, from http://www.afrc.af.mil/newsreleases/story_print.asp?id-123028544

Karbuz, S. (2007). US military energy consumption-facts and figures. *Energy Bulletin*. Retrieved March 6, 2009, from http://www.energybulletin.net/node/29925

Kopp, C. (2008, January). *The US Air Force synthetic fuels program.* Retrieved March 6, 2009, from http://www.ausairpower.net/APA-USAF-SynFuels.html

Lopez, C. T. (2006, September 1). Smart Operations 21 office formed at Pentagon. *Defense AT&L*. Retrieved March 6, 2009 from http://www.thefreelibrary.com/Air Force print news (May 11, 2006): Smart Operations 21 office...-a0152631938

Memorandum on the Energy Independence and Security Act of 2007, 74 Fed. Reg. 4907. (2009, January 26). Retrieved March 6, 2009, from http://www.gpo.gov/fdsys/pkg/DCPD-200900024/pdf/DCPD-200900024.pdf

National Economic Council. (2006, Februrary). *Advanced energy initiative*. Retrived March 6, 2009, from http://georgewbush-whitehouse.archives.gov/stateoftheunion/2006/energy/

Peters, K. M. (2008, August 13). Air Force pushes the envelope on renewable energy. *Government Executive.com*. Retrieved March 6, 2009, from http://www.govexec.com/dailyfed/0808/081308kp21.htm

Posner, J., & Ritter, R. C. (2006). Air Force smart operations in focus; The way ahead. *Air Force Journal of Logistics*, XXXII (2), 1-5.

Richard, J. (2007, December 4). *Nellis to save $1 million annually with use of solar power*. Retrieved March 6, 2009, from http://www.af.mil/news/story.asp?id=123078071

Roeder, T. (2009, March 19). AFA wants to be off the grid by 2015. *The Gazette.com*, Retrieved Jun 8, 2009 from http://www.gazette.com/articles/academy-50261-power-plant.html

Scheina, C. (2008, July 1). Goin' green: Increasing DoD's environment-friendly practices. *Defense AT&L*. Retrieved March 6, 2009 from http://www.thefreelibrary.com/Goin'+green%3a+increasing+DoD's+environment-friendly+practices.-a0181856775

Snyder, J. (2009, January 7). *Eielson Airmen research alternative energy resources*. Retrieved March 6, 2009, from http://www.af.mil/news/story.asp? id=123130481

United States Air Force 2008 Infrastructure Energy Strategic Plan. (2008). Retrieved March 6, 2009, from http://www.afcesa.af.mil/shared/media/document/AFD-081029-038.pdf

United States Air Force Energy Program: Aviation Operations and Fuel Initiatives. (2007, December 12). Retrieved March 6, 2009, from http://www.safie.hq.af.mil/shared/media/document/AFD-071217-095.pdf

United States Air Force Energy Program: Renewable Energy Initiatives. (2007, December 12). Retrieved March 6, 2009, from http://www.safie.hq.af.mil/shared/media/document/AFD-071217-096.pdf

United States Air Force Renewable Energy Program. (2007). Retrieved March 6, 2009 from http://www.af.mil/shared/media/document/AFD-060627-012.pdf

Van Winkle, J. & Imada, J. (2009). *Energy leadership: A legacy to Academy.* Retrieved June 8, 2009, from United States Air Force Academy, Research at the United States Air Force Academy Web site: http://www.usafa.edu/df/dfe/dfer/currentnews.cfm?catname=research

Wasef, B. (2008, September 17). Air Force holds throttle on future of green jet fuel: Test flight. *Popularmechanics.com.* Retrieved March 6, 2009, from http://popularmechanics.smartmoney.com/science/air_space/4283188.html

Weinberger, S. (2008, March 27). Air Force may build nuke reactors in N.M. *Wired.com*. Retrieved March 6, 2009, from http://www.wired.com/dangerroom/2008/03/air-force-may-b/

Woods, H. (2008, July 23). Dorm's cooking oil heading to vehicles. *Ft Collins Coloradoan.* Retrieved March 6, 2009, from http://www.9news.com/includes/tools/print.aspx?storyid=96286