



**DEPARTMENT OF DEFENSE OPERATIONAL ENERGY STRATEGY:
A CONTENT ANALYSIS OF ENERGY LITERATURE FROM 1973-2014**

THESIS

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AFIT-ENS-14-M-26

**DEPARTMENT OF THE AIR FORCE
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Graduate School of Engineering and Management

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Degree of Master of Science in Logistics and Supply Chain Management

Jose A. Quintanilla, BS

Captain, USAF

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7 March 2014
Date

Abstract

Since the 1970s, the U.S. Congress has been concerned with energy policy as a result of the 1973 oil crisis due to the Arab oil embargo. With the Department of Defense (DoD) being the major consumer of energy within the Federal government, specifically as it relates to petroleum-related products (gasoline, diesel, and JP8...), it has been directed to implement cost cutting measures related to energy dependence through numerous Executive orders and Congressional Acts. Therefore, the DoD has mandated that each military service find ways to reduce energy requirements in order to meet both Presidential and Congressional mandates.

This thesis provides a historical review (1973-2014) of energy related literature and identifies current gaps between strategy and research through the use of content analysis. It focuses primarily on operational energy research, but briefly discusses installation energy as it relates to the DoD Operational Energy Strategy.

My sincere appreciation and love to my wife and two little boys. You have been such a blessing in my life and through the course of this program and have always been my haven when times have been tough. You have also endured many sacrifices through this 18-month Master's program and I thank you for sharing the loss of evenings and weekends alongside me—it has only made our family stronger!

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Jose A. Quintanilla

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DEPARTMENT OF DEFENSE OPERATIONAL ENERGY STRATEGY: A CONTENT ANALYSIS OF ENERGY LITERATURE FROM 1973-2014

I. Introduction

“Energy security for the Department [of Defense] means having assured access to reliable supplies of energy and the ability to protect and deliver sufficient energy to meet operational needs.”

—2010 Quadrennial Defense Review

Background

The United States is one of the wealthiest countries in the world, yet it is increasingly held hostage by its insatiable appetite for oil, the majority of which must be imported (Czarnik, 2007). Most of the world’s incremental oil demand is projected for use in the transportation sector, where there are currently no competitive alternatives to petroleum (Energy Information Administration [EIA], 2005). The price volatility of the oil market also places huge strains on our defense budget and with the price of crude oil at \$107 per barrel based on the New York Mercantile Exchange [NYMX] as of 4 September 2013; it’s no wonder that energy is a big concern to the Federal government. This volatility in price was clearly displayed when the price of crude oil spiked to as much as \$145.16 per barrel on July 14, 2008 (as depicted in Figure 1.1) in the midst of one of the worst combinations of economic disasters in recorded history—the collapse of both the housing and financial markets within the United States. However, this event prompted many to do away with the idea that “oil is cheap” and encouraged a renewed focus on changing habits as they relate to energy from the common citizen to the highest positions in government.

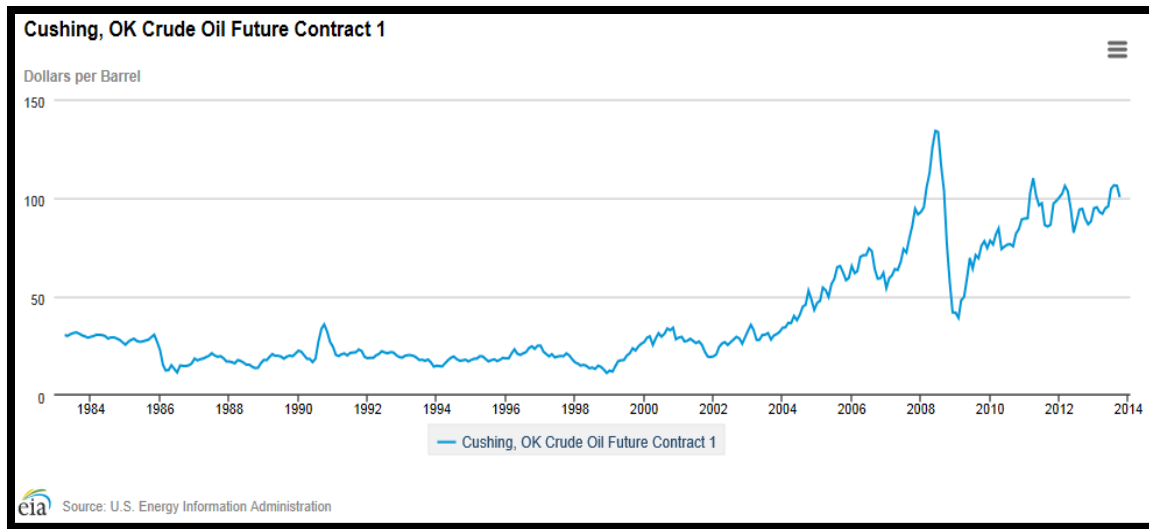


Figure 1.1 Monthly Crude Oil Prices from 1984-2013 in U.S. Dollars per Barrel

Not only has the price of traditional energy sources been a cause for concern, but also their availability. According to the Department of the Navy's, *A Navy Energy Vision for the 21st Century*, "Record oil prices in 2008 provided a glimpse of an energy future where business-as-usual might take us—a future of ever-rising costs and strategic vulnerability" (Navy, 2010). Finally, the effects of climate change and greenhouse gas (GHG) emissions such as rising global temperatures, the melting of the polar ice caps, increased strength of storms and depletion of the ozone layer, are also factors to be accounted for as we strive to free ourselves from our dependency of foreign oil. The EPA defines greenhouse gas as "any gas that absorbs infrared radiation in the atmosphere. They include carbon dioxide [CO₂], methane [CH₄], nitrous oxide [N₂O], ozone [O₃], chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride [SF₆]" (EPA, 2013a).

Adding to the energy dilemma, countries like China and India, who are in the process of rapidly developing their national economies and infrastructure are experiencing an increased demand by their citizens for private vehicle ownership leading to increased energy demands. A

2007 report, sponsored by the Department of Energy, found that total global demand for energy is projected to grow by 50-60 percent by 2030, driven by increasing population and the pursuit of improving living standards (Truths, 2007). As a result, China has made a concerted effort at expanding its petroleum exploration boundaries with the intent of securing viable petroleum sources for future use primarily within East Asia (Zweig *et al.*, 2005). This reality has given our government a cause for concern resulting in a concentrated focus on strengthening relationships with our East Asian partners and strengthening our military presence within the region. While the growth of energy supply is expected to keep pace with this growth in demand, there remains significant uncertainty pertaining to the supply in the energy sector due to world instability (Loechl *et al.*, 2012). A JASON study, accomplished in 2006, states that based on proven reserves, estimated resources, and the rate of discovery of new resources, no extended world-wide shortage of fossil-fuel production is reasonably expected, within approximately, the next 25 years (Dimotakis, 2006). Nevertheless, the U.S. is concerned with imported petroleum both as it relates to national security risk and due to environmental concerns. It is these concerns, amongst others, that will be further studied through the course of this thesis.

Research Purpose

The aim of this thesis is to provide a historical review of energy related policy within the United States government (Executive & Legislative branches, DoD, and military services) and identify current gaps between strategy and available research through the use of content analysis. In the end, it will arrive at a series of conclusions which will provide the reader a better understanding of energy related issues as they concern the United States of America. Specifically, this research aims to answer the following investigative questions:

- 1) What energy related research is being performed by the DoD?
- 2) Is there a current “Master Plan” for DoD operational energy strategy research?

- 3) Is the research supporting the DoD Operational Energy Strategy?
 - a. How?
 - b. Which areas are best supported by current research?
 - c. Which areas are least supported by current research?

The methodology that will be used for the development of this work will consist of a content analysis of Executive orders, congressional legislation, DoD directives and instructions, military policies and plans, Air Force Institute of Technology (AFIT) and Naval Post Graduate School (NPS) theses, Air War College (AWC), U.S. Army War College (USAWC), Air Command and Staff College (ACSC), U.S. Marine Corps Command and Staff College (USMCCSC) and Joint Forces Staff College (JFSC) research papers, as well as peer-reviewed articles from scholarly journals.

Assumptions

Energy related topics can be very large in size and scope. As a result, certain assumptions need to be made in order to keep them at a manageable size. The following assumptions were made in order to limit the study to a manageable and focused area of analysis. (1) The 155 documents analyzed covering the period from 1973 through 2014 are a good representation of existing DoD energy related research documents. (2) The two primary search engines “<http://google.com>” and “<http://scholar.google.com>” as well as the database “<http://dtic.mil/dtic/>” that were used in the literature search were adequate to meet the study’s requirements. (3) The keywords “Energy Policy”, “Energy Legislation”, “Energy Independence”, and “Energy Security” were appropriate in producing relevant energy related literature for this study.

Limitations

A number of limitations are apparent within our study. (1) This research does not consider research conducted prior to 1973. (2) The literature search was primarily restricted to DoD-based topics and focused solely on U.S. energy concerns and (3) the focus of the research is primarily on operational energy rather than installation energy although installation energy is briefly covered.

Significance of Research

This thesis is the first meta-analysis of its kind in performing a content analysis of energy related literature dating from the 1970's to the present while using the DoD Operational Energy Strategy as its lens. It strives to bring a substantial amount of literature on this "hot topic" into a single location that will enable future researchers, policy makers and leaders at all levels to direct their efforts more efficiently. Furthermore, it enables DoD energy research teamwork by presenting a holistic view of our current energy situation. There is ample analysis of energy solutions to the DoD's dependence on fossil fuels ranging from electronic vehicle (EV) adoption to the implementation of an alternative fuels program, but there seems to be no literature that gives serious consideration to all the targets within the DoD Operational Energy Strategy. This thesis will provide a review and framework of the available literature to establish (1) What energy related research is being performed by the DoD? (2) Is there a current "Master Plan" for DoD operational energy strategy research? (3) Is the research supporting the DoD Operational Energy Strategy? (3a) How? (3b) Which areas are best supported by current research? (3c) Which areas are least supported by current research?

What to Expect

The thesis will be laid out in the following order. Chapter II, the literature review, will focus on the energy policies that have been passed by the U.S. Congress and which are the driving force for energy policy implementation within the DoD and ensuing DoD and military policies. Chapter III will present the methodology for conducting the research. Chapter IV will focus on the statistical analysis and assessment of the information collected and determine how best to respond to the investigative questions. Finally, Chapter V will present the conclusions and recommendations.

II. Literature Review

“In little more than two decades we’ve gone from a position of energy independence to one in which almost half the oil we use comes from foreign countries, at prices that are going through the roof. Our excessive dependence on OPEC [Organization of Petroleum Exporting Countries] has already taken a tremendous toll on our economy and our people.... This intolerable dependency on foreign oil threatens our economic independence and the very security of our nation. The energy crisis is real. It is world-wide. It is a clear and present danger to our nation. These are facts and we simply must face them.”

—President Jimmy Carter, televised speech, 15 July 1979

Introduction

The purpose of this chapter is to present a literature review related to energy policy and provide the reader a historical perspective of its evolution. We begin at the global level. Globalization has resulted in increased demand for energy, specifically, crude oil as the primary means to power economic development. As countries continue to develop and societies become more modernized, heavier demands are being placed on the petroleum suppliers of the world. The world is expected to become more populated and urbanized and the global population will increase by approximately 1.2 billion resulting in more than a billion new urban dwellers by 2025 (Mullen, 2011). The advent of globalization, the growing gap between rich and poor, the war on terrorism, and the need to safeguard the earth’s environment are all intertwined with energy concerns (Wirth *et al.*, 2003). It is essentially a supply and demand problem. As demand increases, supply must increase in order to avoid any negative ramifications. Our economy and way of life depend on various sources of energy, the most important of which is oil (Tewksbury, 2006). This situation places great strain on governments around the world, and specifically, the U.S. government as it strives to ensure our continued economic resiliency and security. Furthermore, it is widely known throughout the military that one of the most significant threats to national security is energy dependence (Gerber *et al.*, 2013). It is that growing American

dependence on imported oil that is the primary driver of U.S. foreign and military policy today, particularly in the Middle East (Collina, 2005).

As a result, the U.S. has gone to great lengths in securing viable petroleum resources both within our continental borders and within the major bodies of water that line our coasts in order to become more independent of foreign fuel sources. A 2009 CNA Military Advisory Board report found that U.S. dependence on oil weakens international leverage, undermines foreign policy objectives, and entangles America with unstable or hostile regimes (CNA, 2009). In November 2011, the Department of the Interior (DOI) announced the proposed 2012-2017 Outer Continental Shelf (OCS) Oil and Gas Leasing Program, which makes more than 75 percent of estimated undiscovered technically recoverable oil and gas resources on the U.S. Outer Continental Shelf available for exploration and development (The White House, 2012). According to a 2011 Bureau of Ocean Energy Management (BOEM) estimate, there is in excess of 87.3 billion barrels of undiscovered but technically recoverable oil within the nation's OCS (BOEM, 2011). Figure 2.1 displays the Federal OCS areas of the United States.

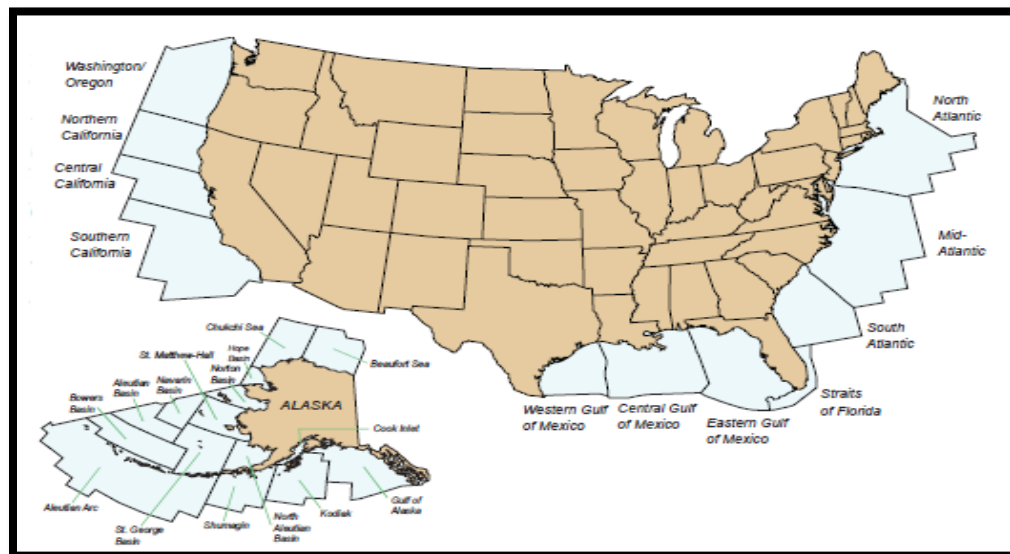


Figure 2.1 (Federal OCS Areas of the United States) Source: Bureau of Ocean Energy Mgmt, 2011.

In 2006, Americans were consuming nearly 21 million barrels of oil per day—a quarter (Alexander, 2008) of the world total of 84 million barrels per day (Kraemer, 2006). The U.S. is the world’s leading consumer of oil yet retains less than two percent of the world’s oil supply (EIA, 2012). The energy markets have a choke hold on the U.S. and, more specifically, our military (Gerber *et al.*, 2013). Surprisingly, the DoD’s consumption of petroleum energy is 1.9% (Schwartz, 2012), a very small percentage of the total U.S. fuel use which two domestic offshore platforms could meet the demand of (Fisher *et al.*, 2007; Lovins, 2010). Nevertheless, the DoD finds itself in a position to really make an impact in the future of energy development. Therefore, in order for Congress to ensure the DoD is making headway within the energy arena, it has codified annual reporting on operational energy management and implementation of operational energy strategy within the *Duncan Hunter National Defense Authorization Act for Fiscal Year 2009* (110th Congress, 2009). By addressing its own fuel demand, DoD can serve as a stimulus for new energy efficiency technologies, and help limit national dependence on foreign oil (Defense Science Board [DSB], 2008).

According to a 2001 report conducted by the DSB task force on improving fuel efficiency of weapons platforms, “it is essential that the DoD support fundamental science investments that can lead to revolutionary improvements in the fuel efficiency of tomorrow’s weapon platform systems” (DSB, 2001). The DoD has the capability to explore better technology to reduce fuel consumption and make equipment more fuel efficient. By doing so, the DoD can also stimulate the economy and allow further development of systems the nation can use to reduce our dependence on foreign fossil fuel and increase our national security (Allen, 2012).

The Inception of Energy Policy

The consequences of the Israeli victory in the Yom Kippur War quickly spread to North America when the Organization of Arab Petroleum Exporting Countries (OAPEC) placed an embargo on crude oil shipped to the United States (Fehner, 1994). The Arab oil embargo, sometimes referred to as “Energy Pearl Harbor Day” (Light, 1976) caused the price of oil to triple overnight, which resulted in gas lines and large price increases at the pump. These price increases not only hurt our [past, present, and future] economic development but disproportionately place a burden borne by lower income groups (Tomam, 2002).

During this crisis President Nixon launched “*Project Independence*,” a list of synthetic-fuel programs (Fialka, 2006) and assured, “In the last third of this century, our independence will depend on maintaining and achieving self-sufficiency in energy” (Potter, 2008). President Nixon further asserted that *Project Independence 1980* is “...set to insure that by the end of this decade, Americans will not have to rely on any source of energy beyond our own” (Fehner, 1994). Therefore, in an effort to achieve energy self-sufficiency by 1980, Nixon urged Americans to lower thermostats, drive cars more slowly, and eliminate unnecessary lighting. He also pledged to increase funding for energy research and development (Fehner, 1994). On the policy front, the only energy legislation passed and signed into law before Nixon resigned was the *Federal Energy Administration Act of 1974*, which established the Federal Energy Administration. Later in 1974, Congress passed the *Energy Reorganization Act*, which created the Energy Resources Council and the Nuclear Regulatory Commission (Potter, 2008). Since Nixon, every U.S. President has made an effort to free the United States of its dependence of foreign fossil fuels.

President Gerald Ford continued President Nixon’s agenda of heightening energy concerns by signing the *Energy Reorganization Act of 1974* which began the consolidation of various departments and administrative staffs that dealt with energy under one umbrella (Black,

2009). He later moved the date for achieving American energy independence to 1985 with the signing of the *Energy Policy and Conservation Act of 1975*. It was this Act that made the fuel efficiency labeling for new car sales a requirement as well as other initiatives like the major appliance energy labels among others. These Corporate Average Fuel Economy (CAFE) standards were an initial means in improving the fuel efficiency of vehicles thus reducing the consumption of fossil fuels. Although the Ford Administration sought sweeping energy policy changes, such as increasing domestic oil production on federal lands and the U.S. Outer Continental Shelf, as well as, increasing tariffs on imported oil, reducing energy consumption through efficiency standards in new buildings and tax credits for homeowners, a strategic oil storage program, and aggressive research and development into new and old energy sources; Congress refused to enact most of President Ford's proposals (Potter, 2008).

President Jimmy Carter, in his 1979 "Crisis of Confidence Speech," declared "Beginning this moment, this nation will never use more foreign oil than we did in 1977—never." He proposed an energy plan of 142 billion dollars that would achieve energy independence by 1990 (Carter, 1979) and established the Department of Energy in August 1977, thereby giving a cabinet level position to the interest of energy (Black, 2009). Additionally, he stressed the importance of developing the new, unconventional sources of energy [alternative energy] we will rely on in the next century (Carter, 1977).

In 1980, the U.S. Congress, through the passing of the *Energy Security Act of 1980*, sought to reduce dependence on foreign energy resources by producing synthetic fuel. It established a national goal of achieving a synthetic fuel production capability equivalent to at least 500,000 barrels per day of crude oil by 1987 and of at least 2,000,000 barrels per day of crude oil by 1992, from domestic sources (96th Congress, 1980). However, this venture never

produced the expected results and was thereby terminated by Congress when it repealed its funding in 1986 (Blumberg, 2013).

President Ronald Reagan signed Executive order (EO) 12287 – “*Decontrol of Crude Oil and Refined Petroleum Products*” in 1981 which eliminated price controls on oil and natural gas. As a result, the price of oil declined and production soared.

In 1991, President George H. W. Bush announced a national energy strategy aimed at “reducing our dependence on foreign oil.” He later funded the U.S. Advanced Battery Consortium with a 260 million dollar research project with the goal of developing lightweight battery systems for electric vehicles (Kraemer, 2006). Later, the *Energy Policy Act of 1992* [EPACT92] sought to account for the full cost of energy. It directed the discussion of least-cost energy strategy as the relative costs of each energy and energy efficiency resource based upon a comparison of all direct and quantifiable net costs for the resource over its available life, including the cost of production, transportation, distribution, utilization, waste management, environmental compliance, and, in the case of imported energy resources, maintaining access to foreign sources of supply (102nd Congress, 1992).

President Bill Clinton’s approach to the energy problem was to propose a large tax on crude oil in order to discourage dependence on foreign sources of oil in 1992. The following year, he launched a billion dollar Partnership for New Generation Vehicles with the Big Three automakers, aiming, by 2004, to produce a prototype car that was three times more fuel-efficient than conventional vehicles (Fehner, 1994). Additionally, he signed EO 13123 – “*Greening the Government through Efficient Energy Management*,” wherein he directed the Federal Government, as the Nation’s largest energy consumer to significantly improve its energy management thereby saving taxpayer dollars and reducing emissions that contribute to air pollution and global climate change (Clinton, 1999). EO 13123 was later revoked by the new and

improved EO 13423 – “*Strengthening Federal Environmental, Energy, and Transportation Management*,” in 2007.

President George W. Bush asserted that addressing the nation’s “energy crisis” was his most important task as president prior the terrorist attacks on the World Trade Center and the Pentagon on September 11, 2001 (Klare, 2004). During his first term in office, he declared, via his 2003 State of the Union address, “to promote energy independence for our country” (Bush, 2003). He announced a 1.2 billion dollar FreedomCAR (Cooperative Automotive Research) proposal to develop hydrogen-fueled vehicles (Kraemer, 2006; Wirth *et al.*, 2003). Additionally, the Bush administration modified the *Energy Policy Act of 2005* and called it the *Energy Independence and Security Act of 2007* as a way to address the country’s energy security concerns (Scofield, 2009). Two key provisions enacted are the CAFE standards which sets a target of 35 miles per gallon for the combined fleet of cars and light trucks by model year 2020 and the Renewable Fuel Standard (RFS) which sets a modified standard that starts at 9 billion gallons of renewable fuel in 2008 and rises to 36 billion gallons by 2022 (Sissine, 2007). The Federal government modified and expanded the *Energy Policy Act of 2005* by taking measures to move toward an energy secure economy within the next few decades and provided funding, which was directed towards various aspects of energy security, including public education in an effort of beginning the paradigm shift, development of innovative non-fossil fuel energy sources, and more efficient use of existing fossil fuel systems (110th Congress, 2007).

In early 2007, Barack Obama, who was then just beginning his campaign for the White House, declared that America must break free of the “tyranny of oil” (Bryce, 2009). In his 2011 “*Blueprint for a Secure Energy Future*,” President Obama continued the assault on the country’s dependency of foreign oil by proposing an ambitious but achievable standard for America. He declared that by 2035, “we will generate 80 percent of our electricity from a diverse set of clean

energy sources—including renewable energy sources” (The White House, 2011). These renewable energy sources were referred to as “soft technologies” by Amory B. Lovins in his 1976 paper “*Energy Strategy: The Road Not Taken?*” (Lovins, 1976), and represent technologies that produce energy from wind, solar, biomass, hydropower, nuclear power, natural gas, and clean coal (The White House, 2011). On the energy security front, the Obama administration gave it its due share of benefits through the passing of the \$800 billion dollar *American Recovery and Reinvestment Act of 2009* (ARRA) also called the *Recovery Act of 2009*. The energy portion alone consisted of approximately \$50 billion dollars whereby the largest partition of that money (\$11B) was appropriated for development of an electric “smart grid” to digitize power distribution and improve the grid’s efficiency (Scofield, 2009). Additionally, the DoD is moving aggressively to integrate alternative fuels on its bases, ships, and aircraft from the \$7.1 billion in “stimulus” appropriations by the “ARRA” to, among other things, modernize DoD’s energy infrastructure and conduct targeted energy efficiency research and development projects (Rosen, 2010). Through the *Recovery Act*, President Obama was able to get \$90 billion invested in clean energy which resulted in the creation of 224,500 American jobs and tens of thousands of domestic renewable energy projects (The White House, 2011). Finally, the Obama administration is now pushing automakers to hit a 54.5 miles per gallon fleet-wide average by 2025 as a means of increasing vehicle’s fuel efficiency and thus reducing the consumption of fossil fuels (Krauss *et al.*, 2012).

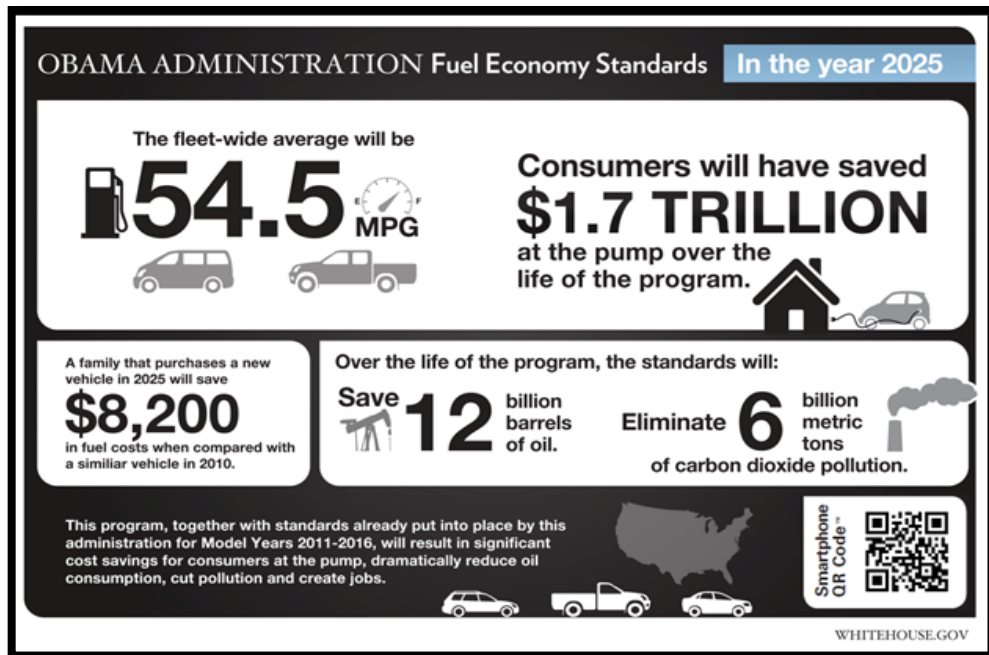


Figure 2.2 Obama Administration Fuel Economy Standards in the Year 2025; Source: WHITEHOUSE.GOV

As of 2012, in an effort to further shield the U.S. from potential negative oil fluctuations, Congress passed legislation that provided for the creation of a Strategic Petroleum Reserve (SPR) capable of reducing the impact of severe energy supply interruptions (EPCA, 2012). When filled to its 727 million barrel capacity, the SPR represents roughly 70 days of imported supply (Daggett, 2010). However, the formal requirement for the SPR was established in December 1975, when President Gerald Ford signed the *Energy Policy and Conservation Act* which declared it U.S. policy to establish a crude oil reserve of up to one billion barrels (Peck, 2006). The greatest benefit of having an [oil] stockpile, like that of the nation's nuclear arsenal, may be its mere existence, which would reduce the prospects for successful oil blackmail and deter hostile states from attempting to cut back oil production or to disrupt U.S. oil imports (Coon *et al.*, 2002).

The importance of energy policy is noted within the executive summary of the 1980, Defense Energy Management Plan, as it states: “United States national security objectives can be achieved only if we are thoroughly prepared to meet essential military energy requirements. For the longer term, we need to avail ourselves of more secure, plentiful energy resources through technological advances.” (Defense Energy Management Plan, 1980). The *Alternative Motor Fuels Act of 1988* further cements this through Congress’ declaration that “the achievement of long-term energy security for the United States is essential to the health of the national economy, the well-being of our citizens, and the maintenance of national security.” It goes further in stating that the displacement of energy derived from imported oil with alternative fuels will help to achieve energy security (100th Congress, 1988). Therefore, the first step towards long-term petroleum independence is reducing consumption. There are many possible methods to achieve this goal, but all must work together synergistically to achieve the desired effect (Meyer *et al.*, 2010). Recently, Congress’ *Roadmap for America’s Energy Future* promotes the expansion of domestic fossil fuel production, develops more nuclear power, and expands renewable electricity (112th Congress, 2011). This approach has taken effect since the height of our petroleum dependence in 2005 when we were consuming 7.6 million barrels of crude oil per day (as depicted in Figure 2.3). Our country’s commitment at attempting to solve the energy problem is readily apparent within the aforementioned material. Each U.S. President, as well as numbered congress, have taken steps in moving us forward as we continue to unravel the energy problem as a means of attaining a suitable energy solution for the future.

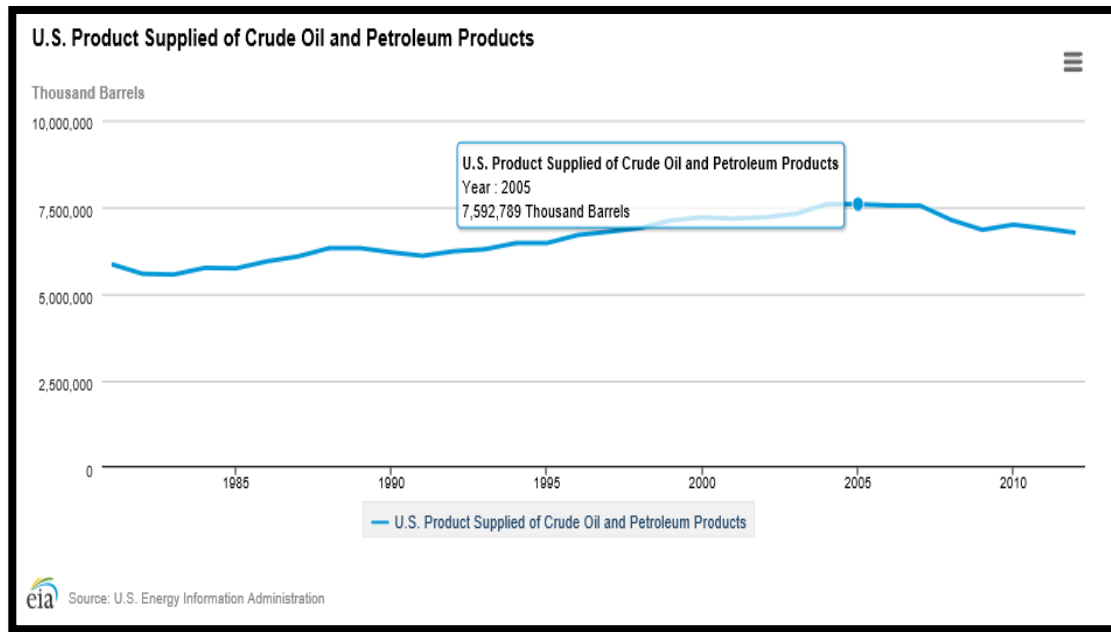


Figure 2.3 Average Yearly Crude Oil Consumption from 1981-2012 in Million Barrels per Day

Congressional Action

Since the 1970s, Congress has been concerned with energy policy and has passed legislation relating to Federal government energy use (Schwartz, 2012). *The Energy Policy and Conservation Act*, signed by President Ford on December 22, 1975, was a first step towards a comprehensive and systematic Federal energy policy (94th U.S. Congress, 1975). This policy was the inception of many standard energy-focused items we see today, like the first automobile average fuel economy standards, the requirement for new vehicles for sale to have a label depicting the automobile's fuel efficiency, major appliance energy labels, light efficiency standards for new buildings, and allowing right turns on red lights.

The Energy Information Administration, a semi-independent agency of the U.S. Department of Energy (Taylor *et al.*, 2002), forecasts that U.S. dependence on petroleum imports will increase to 68 percent by 2025. As a result of the *Energy Policy Act of 2005*, Congress

established a United States commission to make recommendations for a coordinated and comprehensive North American energy policy that would achieve energy self-sufficiency by 2025 within the three contiguous North American nation areas of Canada, Mexico, and the United States. It was called the “*Set America Free Act of 2005*” or “SAFE Act” (109th Congress, 2005). In an effort to further align the DoD with Congress’ energy policies, the Assistant Secretary of Defense for Operational Energy Plans and Programs (ASD(OEPP)) position was established consistent with 10 U.S.C. § 138c (DoD Operational Energy Strategy, 2011). In 2012, the (ASD(OEPP)) established a Certification Advisory Working Group (CAWG) composed of representatives from the (ASD(OEPP)) office, the Office of the Under Secretary of Defense (Comptroller), Office of the Director for Cost Assessment and Program Evaluation (CAPE), the Joint Staff, the Services, and Defense Logistics Agency. The CAWG reviews and evaluates each component’s operational energy efforts and provides recommendations on the adequacy of resourcing for each target (DoD, 2012b).

Department of Defense

The Federal government as a whole accounts for less than 2 percent of the total national consumption, but the DoD consumes over 96 percent of that. The Air Force consumes 51.7 percent, the Navy 29.2 percent, the Army 16.8 percent, the Marine Corps 1.4 percent, and other DoD agencies 0.7 percent (DESC, 2007). Figure 2.4 presents the breakdown of DoD energy usage.

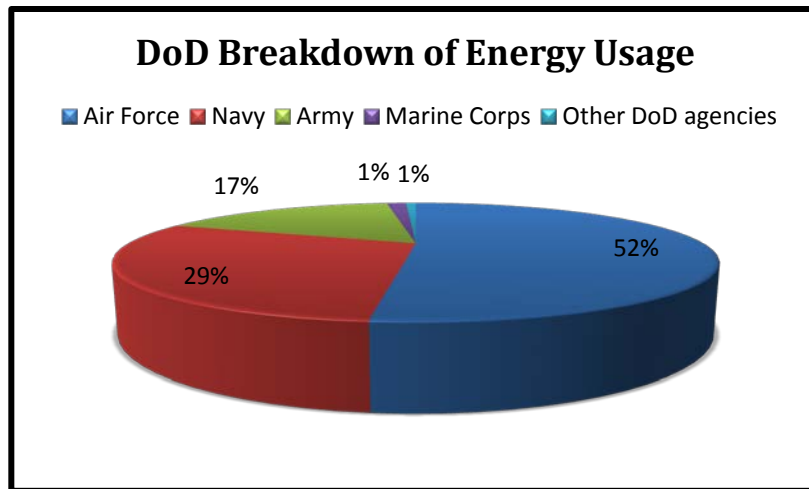


Figure 2.4 DoD Breakdown of Energy Usage

The DoD is the largest single U.S. consumer of energy, consuming 3.8 billion kilowatt hours (kWh) of electricity and over 120 million barrels of oil per year, (Gauntlett, 2012) having peaked at 145 million barrels in Fiscal Year (FY) 2003 (as shown in Figure 2.6), and also relies on foreign supplies of crude oil and the finished transportation fuels (such as military jet fuel) that are derived from it (Dimotakis, 2006). As a result, the DoD spends billions of dollars per year on fuel (as shown in Figure 2.5), and is pursuing numerous initiatives for reducing its fuel needs and changing the mix of energy sources that it uses (Blakely, 2012). Therefore, the DoD Operational Energy Strategy sets the overall direction for operational energy security for the Office of the Secretary of Defense (OSD), Combatant Commands, Defense Agencies, and Military Departments/Services (DoD Operational Energy Strategy, 2011). The goal of the DoD Operational Energy Strategy is energy security for the Warfighter—to assure that U.S. forces have a reliable supply of energy for 21st century military missions (DoD, 2012a). Furthermore, the four service departments have been charged with three principle ways, which we will refer to as “*Category I, II, and III*” through the course of this study, to a stronger force within the current DoD Operational Energy Strategy (DoD, 2011) and it is these energy objectives and the ensuing

seven targets the DoD published in its *Operational Energy Strategy: Implementation Plan* (DoD, 2012a) that are the criteria which are used to evaluate the certification of the DoD Components' proposed budgets.

Category I: “More Fight, Less Fuel” Reduce Demand for Energy in Military Operations.

Today's military missions require large and growing amounts of energy with supply lines that can be costly, vulnerable to disruption, and a burden on Warfighters. The Department needs to improve its ability to measure operational energy consumption, reduce demand, and increase the efficiency of energy use to enhance combat effectiveness (DoD, 2012a)

- o **Target 1:** Measure Operational Energy Consumption.
- o **Target 2:** Improve Energy Performance and Efficiency in Operations and Training.
- o **Target 3:** Promote Operational Energy Innovation.

Category II: “More Options, Less Risk” Expand and Secure Energy Supplies for Military Operations.

Reliance on a single energy source—petroleum—has economic, strategic, and environmental drawbacks. In addition, the security of energy supply infrastructure for critical missions at fixed installations is not always robust. The Department needs to diversify its energy sources and protect access to energy supplies to have a more assured supply of energy for military missions (DoD, 2012a).

- o **Target 4:** Improve Operational Energy Security at Fixed Installations.
- o **Target 5:** Promote the Development of Alternative Fuels.

Category III: “More Capability, Less Cost” Build Energy Security into the Future Force.

While the force's energy requirements entail tactical, operational, and strategic risks, the Department's institutions and processes for building future military forces do not systematically consider such risks and costs. The Department needs to integrate operational energy considerations into the full range of planning and force development activities (DoD, 2012a).

- o **Target 6:** Incorporate Energy Security Considerations into Requirements and Acquisition.
- o **Target 7:** Adapt Policy, Doctrine, Professional Military Education, and Combatant Command Activities (Change Culture).

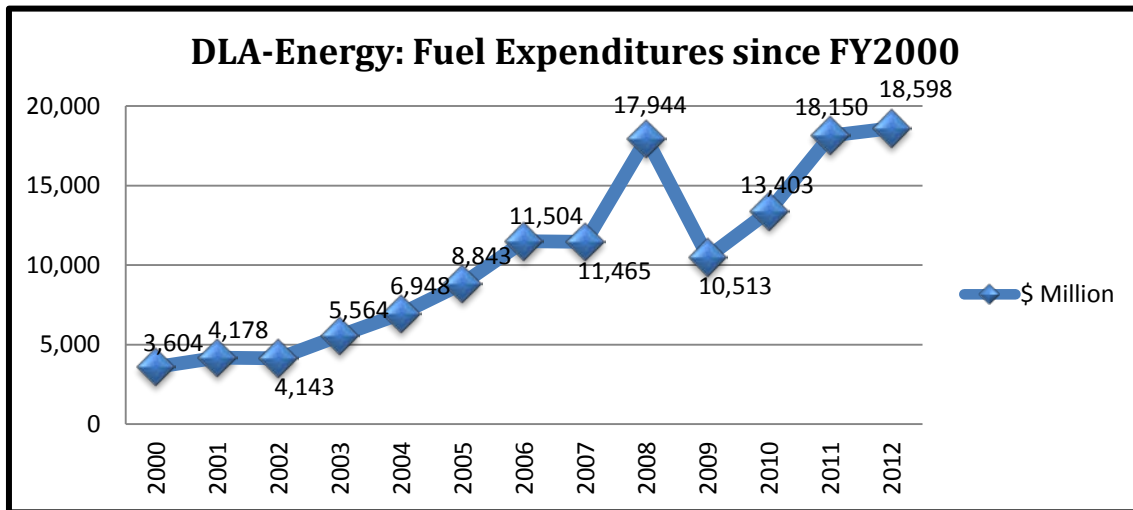


Figure 2.5 (DLA-E: Fuel Expenditures since FY2000) Source: DESC, Fact Books (FY2000 through FY2012), <http://www.energy.dla.mil/Pages/default.aspx>

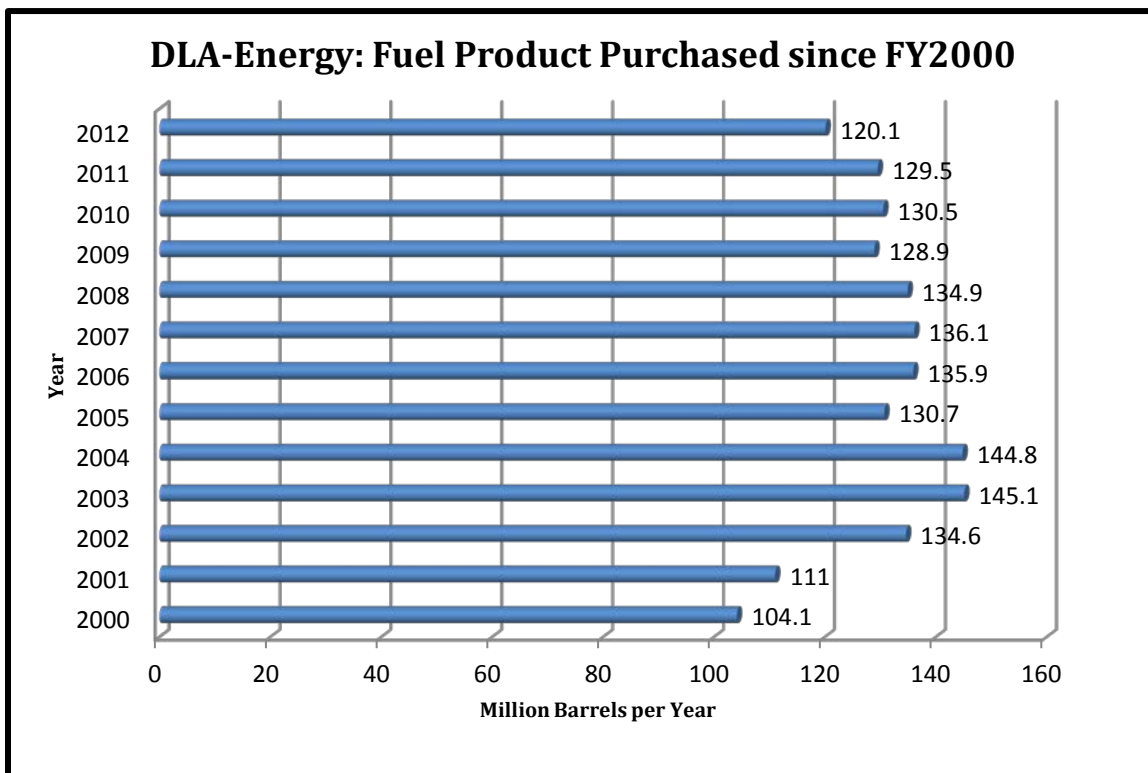


Figure 2.6 (DLA-E: Fuel Product Purchased since FY2000) Source: DESC, Fact Books (FY2000 through FY2012), <http://www.energy.dla.mil/Pages/default.aspx>

All military branches have developed their own policies with respect to energy and have been actively engaged in energy reduction efforts as well as alternative energy initiatives—a process often referred to as decarbonization (Shinnar *et al.*, 2008) as they relate to the various weapon systems in use. As of 14 December 2012, the services (the Army, Navy, and Air Force) have spent approximately \$48 million on alternative fuels, and the Navy has proposed a \$170 million investment in biofuel production capability. By comparison, DoD purchases of petroleum fuels totaled \$18.1 billion in FY2011 (Defense Logistics Agency Energy, 2013). This stark contrast in alternative fuels investment versus petroleum fuels purchases provides us with a clear picture of just how small the “drop-in-the-bucket” investment within the alternative energy arena really is. This would lead us to believe that we’re not making as great an impact in reversing our dependency of conventional fuels as we might have imagined. Nevertheless, progress is being made by each military branch as they strive to meet both Federal and DoD mandates and policies. A brief summary of each department’s characteristics and actions/initiatives, as they relate to energy, are presented in the following pages.

U.S. Air Force

Being the largest consumer of energy within the DoD, the U.S. Air Force (USAF) finds itself in a very unique position to make a substantial difference within the arena of energy research, development, and implementation. The Air Force, which purchases most of the DoD’s aviation fuel, bears the largest share of costs (Blackwell, 2007). In 2007s *Air Force Energy Plan*, the USAF’s vision with respect to energy was, “Make Energy a Consideration in All We Do.” However, the 2013s new and improved USAF’s energy vision is much more specific, “Sustain an Assured Energy Advantage in Air, Space, and Cyberspace” (Air Force Energy Strategic Plan, 2013). As such, the original Air Force Energy Plan was built upon three primary pillars: *Reduce Demand*; *Increase Supply*; and *Culture Change* (Air Force Energy Plan, 2010). However, the

2013 U.S. Air Force Energy Strategic Plan enhanced these to become four priorities: *Improve Resiliency; Reduce Demand; Assure Supply; and Foster an Energy Aware Culture*. The Air Force goals were to test and certify all aircraft and systems on a 50/50 alternative fuel blend by 2012, and to be prepared to acquire 50% of the Air Force's domestic aviation fuel as an alternative fuel blend by 2016 (Blackwell, 2007; The Pew Project, 2009; Blakely, 2012). It has also demonstrated national leadership in adopting renewable energy at its installations through the purchase of 5 percent of its electricity from green power sources. The Air Force is the Federal government's leading purchaser of green power electricity and ranks 7th overall in the nation (Allen, 2012) and is the only branch of the military to have met its facility energy goals (The Pew Charitable Trusts, 2014).

U.S. Navy

The U.S. Navy is the second largest consumer of energy within the DoD and plays a big part in facilitating the flow of petroleum products around the world by providing and ensuring a stable zone of commerce (Navy, 2010). The Navy's energy vision is as follows, "Our Energy Vision is a Navy that values energy as a strategic resource; a Navy that understands how energy security is fundamental to executing our mission afloat and ashore; and a Navy that is resilient to any potential energy future" (DoD, 2011). The vision is built upon three key areas: *Assure Mobility and Protect Critical Infrastructure; Lighten the Load and Expand Tactical Reach; and Green the Footprint*.

Currently, the U.S. Navy is facing a major challenge to sustain and operate its current and future force structure within the projected budgets due to volatile and rapidly rising energy costs (Doerry *et al.*, 2010). In order to administer efficiency and conservation efforts on installations, the Navy established the Shore Energy Office in the 1980s, in response to Federal and DoD

mandates (Navy, 2010). Accordingly, with respect to alternative energy, the Navy is the largest producer in the Federal government due to its nuclear-powered sea vessels.

The Navy's goals are to reduce petroleum use in its commercial vehicle fleet by 50 percent by the year 2015 (DoD, 2011), deploy a "Great Green Fleet" strike group of ships and aircraft running entirely on alternative fuel blends by 2016 and to meet 50% of the Navy's total energy consumption from alternative sources by 2020 (Andrews, 2012). To date, the Navy has certified the F-18 Super Hornet, the F-18 legacy Hornet, the MV-22 Osprey, and the MH-60 Seahawk to operate on HRJ-5, a 50/50 blend of hydrotreated renewable fuel (HRJ) and conventional JP-5 (Tindal, 2011). Additionally, by installing stern flaps, which reduce drag and the energy required to propel a ship through the water, the Navy has already generated annual fuel savings of up to \$450,000 per ship (Navy, 2009). Finally, the Navy has a lower dependence on petroleum than other services because its aircraft carriers and submarines are nuclear-powered. In FY2010, the Navy met 59% of its overall energy needs with petroleum, 22% from nuclear-powered ships, and 19% from electricity (Blakely, 2012). According to Vice Admiral David Architzel, "Energy is a strategic resource that is critical to the success of the Navy and Marine Corps. Its availability on the battlefield and price volatility in the marketplace present potential vulnerabilities to both the Warfighter and our national security" (Navy, 2012). The Secretary of the Navy: Honorable Ray Mabus also voiced his concern with the Navy's dependence on fossil fuels when he stated: "The necessity of fossil fuels exposes vulnerabilities in our ability to perform the dynamic U.S. Navy amphibious mission following a drawdown of sustained high intensity conflict in Iraq and Afghanistan" (Martin *et al.*, 2012). Nevertheless, the Navy is being proactive within the energy arena in finding solutions to its energy challenges through innovative approaches that are now available thanks to recent technological developments.

U.S. Army

With the Army consuming less than one-half of one percent of the total U.S. consumption of petroleum-based fuels, it will clearly not be the driver to solutions but needs to concentrate on being able to use the solutions the market develops (Council, 2009). The U.S. Army has the broad aim of increasing the use of renewable energy, but has not adopted any specific alternative fuel goals (Schwartz, 2012). Its energy vision is “An effective and innovative Army energy posture, which enhances and ensures mission success and quality of life for our Soldiers, Civilians and their Families through Leadership, Partnership, and Ownership, and also serves as a model for the nation” (DoD, 2011). The vision is built upon five pillars: *Reduce Energy Consumption; Increase Energy Efficiency across Platforms and Facilities; Increase use of Renewable/Alternative Energy; Assured Access to Sufficient Energy Supplies; and Reduced Adverse Impacts on the Environment.*

The Army is currently testing 50/50 blends of Fischer-Tropsch synthetic paraffinic kerosene and HRJ with JP-8 for use in all Army ground systems and field generators, with the goal of certifying these fuels by 2014 (DoD, 2011). The Army released its *Army Energy Security Implementation Strategy* (AESIS) in 2009. It looks to increase energy security by forwarding energy options that ensure surety, survivability, supply, sufficiency, and sustainability (Council, 2009).

According to the 2009, *Army Capstone Concept*, renewable energy and improvements in the management of fuel and electric power requirements offer the potential for greater fuel efficiency, advances in engine designs, and improved power generation. Increased energy efficiencies hold promise for reduced logistical demand and an ability to retain freedom of movement and action across great distances (U.S. Army Training and Doctrine Command, 2009).

U.S. Marine Corps

In August 2009, the Commandant declared energy a top priority for the U.S. Marine Corps (USMC). He went on to create the USMC Expeditionary Energy Office (E²O), with the mission of analyzing, developing, and directing “the Marine Corps’ energy strategy in order to optimize expeditionary capabilities across all warfighting functions” (DoD, 2011). The USMC published the *United States Marine Corps Expeditionary Energy Strategy and Implementation Plan “Bases-To-Battlefield”* in 2011 as a means of aligning themselves with guidance and mandates for operational and installation energy established by civilian and military leadership (USMC, 2011). As of 2011, the USMC consumed more than five million barrels of petroleum a year—or about 16% of the total consumption of the Department of the Navy (USMC, 2011). Their energy vision is “To be the premier self-sufficient expeditionary force, instilled with a warrior ethos that equates the efficient use of vital resources with increased combat effectiveness” (DoD, 2011). The vision is also built upon three key points: *Instill an Ethos; Increase Energy Efficiency in USMC Equipment and Installations; and Increase Use of Renewable and Alternative Energy.*

In summary, each military service has sought energy conservation and improvement measures as they pertain to their service’s main focus areas. The Air Force has sought to improve its aircraft’s ability to perform by certifying many of its aircraft to operate with a 50/50 alternative fuel blend and increasing its renewable energy usage within its installations. The Navy also has certified many of its air assets to operate with an HRJ-5, 50/50 blend fuel and is focusing on operating its sea assets on alternative fuel blends. Finally, both the Army and Marine Corps are striving to enhance their ground capabilities by incorporating alternative fuels and renewable energy sources into their ground units and finding ways of making their equipment more energy efficient and resilient within the battlefield.

A Leadership Issue

True culture change of any large organization must start at the top (Lengyel, 2007). Leadership is the key to promoting and incentivizing new programs, policies, and changes. The same holds true within the energy arena as we strive to minimize our energy requirements and use. History has proven that with strong leadership one can successfully move individuals, communities, and nations through change (Gallant, 2006). Leadership must begin promoting the message that (fuel) efficiency at the tactical platform and system level is a clear strategic path to improve performance, reduce logistics burden and free resources from modernization and readiness (DSB, 2001). The CNA Military Advisory Board identified in its May 2009 report that DoD leadership must take an active role in transforming its energy posture and stated “...leadership must demonstrate the proper focus and attention...” for development, testing, and deploying new technologies as the DoD’s role in national security (Allen, 2012).

President Obama’s Executive order 13514 on *Federal Leadership in Environmental, Energy, and Economic Performance* deals with this dilemma by making it the responsibility of every Federal agency to help move the nation toward a clean energy economy by leading by example, practicing what we preach, and improving the government’s energy efficiency while expanding our use of clean energy (The White House, 2011). The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) has been directed to ensure the implementation of President Bush’s 2007 Executive order and to “continue efforts of the Energy Security Task Force by implementing the findings and monitoring implementation.” However, there does not appear to be an individual within that office appointed to oversee a comprehensive department-wide energy strategy—to prioritize, coordinate, and advocate for the various ongoing projects (Blackwell, 2007).

A Funding Issue

The reason that DoD should be concerned about the instability of the price more than the (high) absolute value of the price itself is that unstable prices are unpredictable, and therefore they severely compromise the ability of DoD to budget and plan for the future (Fisher *et al.*, 2007). For instance, a \$10/barrel increase in the price of crude oil would correspond roughly to about a \$1.5 billion increase in the total annual DoD fuel cost ($\$10/\text{barrel} \times \sim 150 \text{ million barrels/year} = \1.5 billion). Therefore, if fuel costs exceed the amount budgeted for them, then they are financed by taking money from the budgets of other programs. This can severely affect other DoD programs, if not cancel them entirely (Fisher *et al.*, 2007).

An Environmental Concern

For many years now, we've been told, that the burning of fossil fuels is having a measurable and dangerous effect on the climate. Avoiding dangerous climate change motivates an immediate change from our current use of fossil fuels (MacKay, 2008). The United States emits more greenhouse gases to the atmosphere than any other nation. With 4½ percent of the world population, the U.S. emits approximately 25 percent of global man-made greenhouse gases and consumes approximately 25 percent of the world's energy (DSB, 2001), (Davis *et al.*, 2007). The U.S. releases 2.4 billion tons of carbon into the atmosphere each year. That translates to 152,200 pounds every second—the weight of an Abrams tank (Custer, 2007). The United States needs an energy security strategy the entire nation can support in order to cut our dependence on oil and our emissions of greenhouse gases (Center for a New American Security [CNAS], 2008). Already, the carbon lodged in the atmosphere by the Industrial Revolution over the last 150 years has taken a toll: disappearing glaciers, a thinning Arctic icecap, dying coral reefs, and increasingly violent hurricanes (Kraemer, 2006). Although there has been added pressure for the

U.S. to increase its domestic production of fossil fuels as a means of alleviating the dependency of foreign produced fossil energy, critics of domestic oil production argue that fossil fuels are destroying the environment and play a role in global warming by increasing the amount of carbon in the atmosphere (Weidenmier, 2008).

A National Security Issue

Our country's, and for that matter, the world's, dependence on foreign oil results in our increased vulnerability to potential oil shortages and fluctuations within the world energy market. The real issue is not so much that we're "running out" of oil, since the world has hundreds of years of existing and potential reserves (Tomam, 2002; Verrastro *et al.*, 2007) as depicted in Figure 2.7, but more so that we are placing increasing demands on the current supplies/reserves of oil. The problem will be that production will no longer be able to keep pace with the exponential demand for oil (Nygren *et al.*, 2006; Hirsch *et al.*, 2005) and emerging technologies are not yet commercially viable to fill shortages and will not be for some time (Morse, 2001). This fact is one that the country has grappled with since Jimmy Carter was President of the United States in the late 1970s. He stated that demand would overtake production sometime in the 1980s (Carter, 1977). As it happens, due to increased production, to this date, production has been able to keep up with demand; however, we may just be getting closer to the tipping point where demand does indeed surpass global production levels unless additional production capacity is built in preparation for the forecasted increases in global demand.

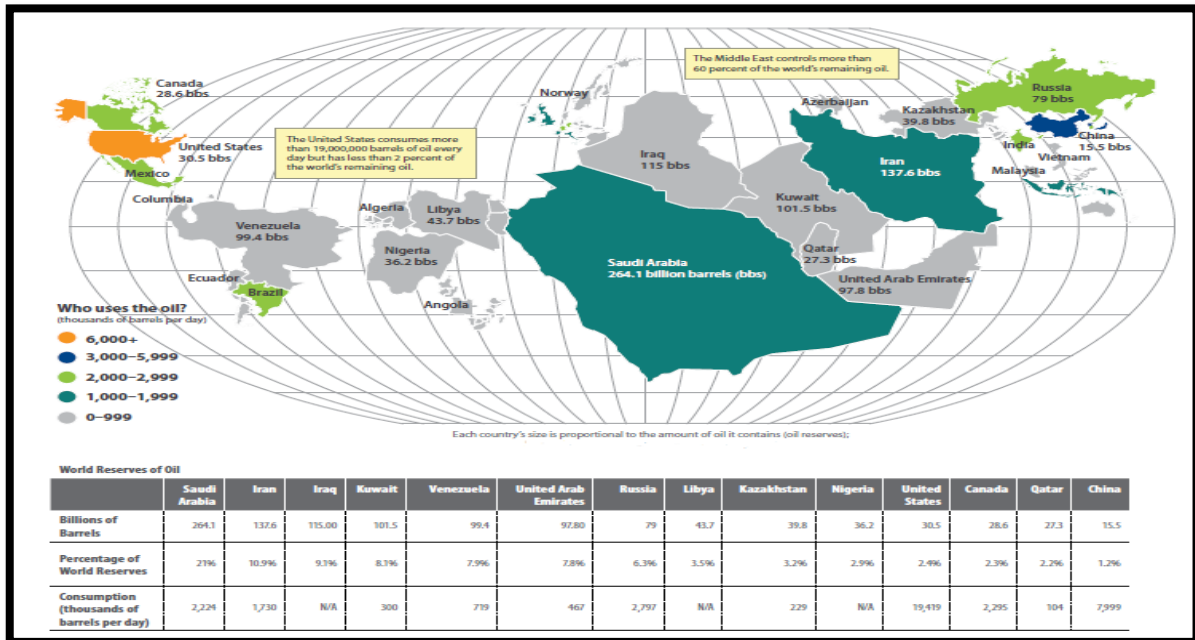


Figure 2.7 (2009 Scaled Map of World Oil Reserves) Source: Air Force Energy Plan 2010

Since our demand for fossil fuels is far greater than what our domestic supply is currently capable of fulfilling, we have no choice but to seek viable sources of fuel outside our borders, in many cases, within countries that have opposing political and national interests. Furthermore, the economic cost of dependence on foreign oil is staggering (Stein, 2011). The high oil prices of 2008 fueled one of the biggest wealth transfers in history (Haigh, 2009). At the time, the U.S. was importing some 60% of its oil from foreign sources resulting in prices adversely affecting our trade balance (DSB, 2008). The truth is that oil from the Middle East accounts for less than 20 percent of total U.S. imports, but the Middle East, because of its large global market share, effectively sets prices for all oil, regardless of its origination (Fisher *et al.*, 2007). Figure 2.8 shows the top 10 importing countries of 2013 and Figure 2.9 displays the total U.S. imports of crude oil since 1910.

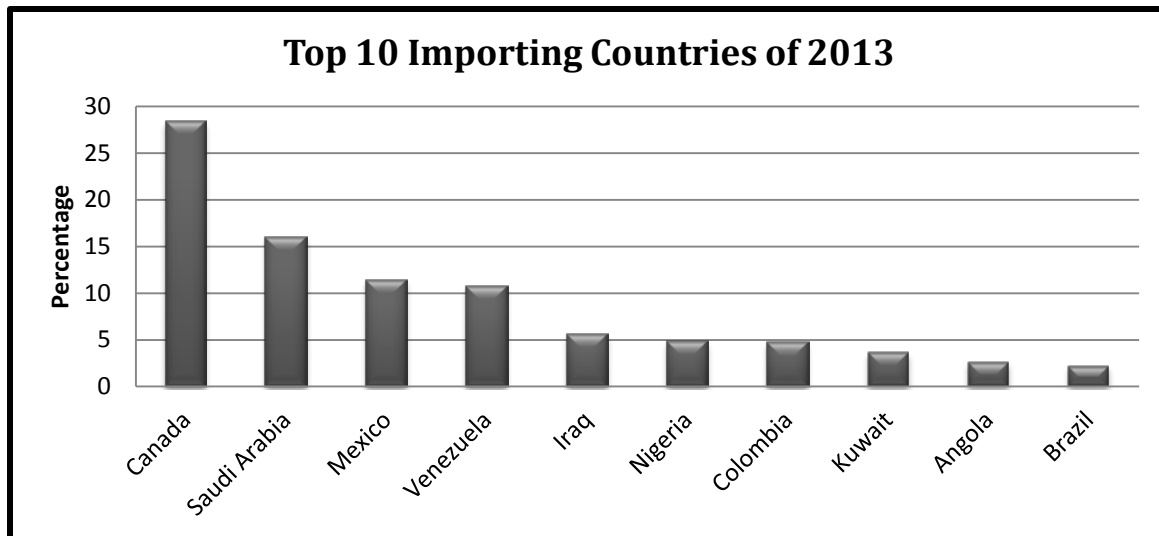


Figure 2.8 (Top 10 Importing Countries of 2013) Source: U.S. Energy Information Administration, <http://www.eia.gov/petroleum/supply/weekly/pdf/table8.pdf>

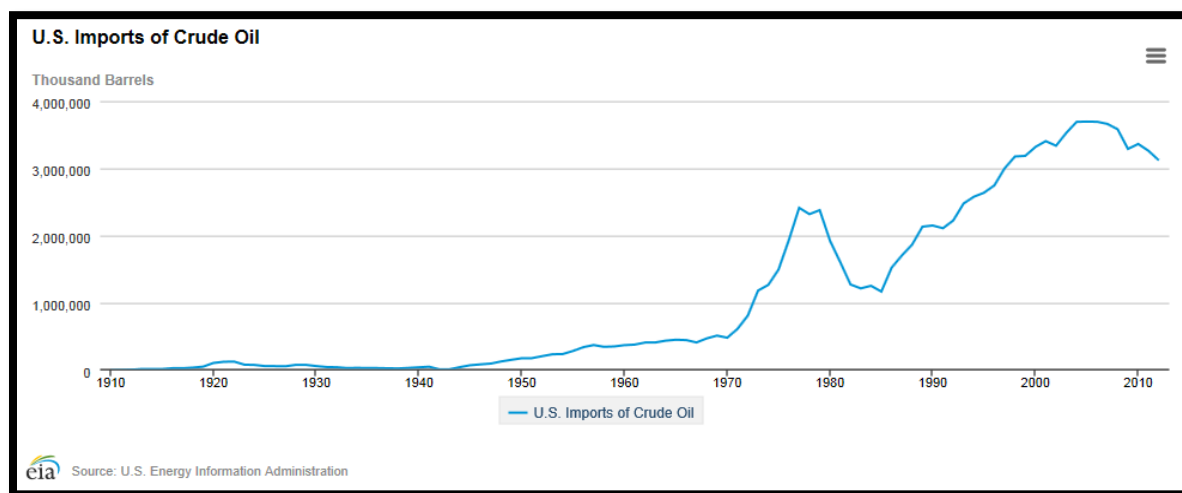


Figure 2.9 Total U.S. Imports of Crude Oil (Thousand Barrels per Day)

According to Powers (2010), the U.S. has an oil trade deficit of approximately \$1 billion dollars per day (Halff, 2008), larger than our trade deficit with China, which in 2010 was approximately \$748,000,000 per day (U.S. Census, 2011). This massive outflow of capital not only weakens our national economy by increasing our trade deficit, but has the potential of enriching countries who may wish to harm us. In essence, the money from the United States to

potentially hostile countries enables those nations to purchase the most advanced military technology and the human expertise to further develop and deploy it (Stein, 2009).

Former national security adviser Robert McFarlane and former CIA director James Woolsey, described our dependence on foreign oil as, “the well from which our enemies draw their political strength and financial power: the strategic importance of oil, which provides the wherewithal for a generational war against us” (McFarlane, 2011). Time and again, the U.S. military and national security leaders have warned of the substantial risk this outflow of capital poses to the security of the United States (Stein, 2011). However, due to the increasing demands of petroleum fuels from developing countries like China and India, the offending oil regimes will enrich themselves whether or not America does business with them (Nivola, 2008). This fact leaves us in a perilous situation where our decreased demand for foreign sources of energy will only result in others filling that energy demand vacancy.

The reality is that fossil sources of energy are becoming more of a precious commodity as the world demand for them continues to rise without abate. This is contributing to the creation of a dangerous energy situation in which the power to ensure access to international energy resources has shifted away from energy consumers to energy producers (Gallis, 2006). To complicate matters further, oil and gas resources are concentrated in a small region of the world, leading to a more fragile and more volatile trading system that shows strong monopolistic tendencies (Lackner *et al.*, 2005). The Arab Oil embargo of 1973 was one of the first examples of this reality. Jordan Paust and Albert Blaustein (1974), in their book, *The Arab Oil Weapon—A Threat to International Peace*, referred to this as, the oil ‘weapon’.

Within the past decade, we’ve seen examples of some energy producers showing a tendency to use oil and gas for political leverage. In December 2005-January 2006, when Russia dramatically raised the price of natural gas that it was supplying the Ukraine, many saw it as an

effort to squeeze Ukraine politically and economically to secure Kiev within Russia's orbit (Gallis, 2006). Looking further into history, the first Gulf War (1991) was fought not only to liberate Kuwait from Saddam Husain, Iraq's president, but also to ensure that Iraq did not control Kuwaiti oil and threaten Saudi Arabia and other Gulf producers (Gallis, 2006).

Finally, as a further complication to the U.S. energy security issue, China, with its ever growing economy is placing increasing demands within the energy market. Chinese leaders have increased Beijing's influence in oil-producing states like Venezuela and countries within Central Asia and the Middle East. As a result, some of these relationships have strengthened the hand of dangerous regimes looking for an alternative to the United States (Blumenthal, 2008).

Venezuela's President Hugo Chaves, boasted that no longer will the United States be the dominant consumer of Venezuelan oil; now, "[Venezuela is] free and place[s] this oil at the disposal of the great Chinese fatherland" (Blumenthal, 2008). The changed energy landscape with respect to China now being the world's second largest oil importer, following the U.S., will only result in increasing our national security vulnerability as it applies to our petroleum energy dependency. To quote Carroll L. Wilson's first sentence of his July 1973 article for *Foreign Affairs*, "I believe the United States is facing a national energy emergency" (Wilson, 1973).

Energy Independence "Myth"

We may just be arriving to the conclusion that true energy independence is not an attainable goal within our current global energy environment. The reality is that the national energy system is highly interdependent (Hogan, 1975; Morse, 2001). Globalization has evolved to a point where all countries are reliant of each other-especially amongst those with large economies that have increased trade relationships. Oil is truly the lubricant that facilitates the movement of the world's products for which we all depend upon. Some researchers believe that if we actually were to attain energy independence, it would come at a cost of several trillion

dollars per year in reduced Gross Domestic Product (GDP), and we would obtain little or no benefit from such a suicidal effort (Pierce, 2007).

Robert Bryce, in his book, *Gusher of Lies: The Dangerous Delusions of “Energy Independence”*, states that none of the alternative or renewable energy sources now being hyped—corn ethanol, cellulosic ethanol, wind power, solar power, coal-to-liquids, and so on—will free America from imported fuels. This is due to the fact that America’s appetite is simply too large and the global market is too sophisticated and too integrated for the U.S. to secede (Bryce, 2008).

Threat to Alternative Energy

Without a doubt, the single-largest threat to the development and implementation of substantial alternative energy technologies is directly linked to the cost of oil. Additionally, the current energy infrastructure, built over the last century, was designed to enable the reliable production and delivery of low-cost fuels to consumers (Verrastro *et al.*, 2007). As a result, this infrastructure has been one of the major cost advantages for the continued use of traditional fossil fuel resources over other sources of energy, such as renewables (Verrastro *et al.*, 2007), or alternative fuels.

The high oil prices and fears of running out of oil in the 1970s and early 1980s encouraged investments in alternative energy sources, including synthetic fuels made from coal, but when oil prices fell, investments in these alternatives became uneconomical (Found, 2007). Additionally, the problem with alternatives to petroleum—such as shale oil and coal—is that they often require more energy to extract and use than they actually produce (Goodstein, 2005). Investors and potential innovators know that if they do come up with a product that competes with oil at anything like current prices, the Saudis, who can produce oil for around 5 dollars per

barrel, can always lower the price and wipe them out (EIA, 2005). Furthermore, our economy is extremely dependent on transportation which itself runs primarily on petroleum-based fuels which are a source of mobility for American society—the combination of relatively low production costs and high energy density make it very attractive for this purpose (Hornitscheck, 2006).

Furthering the threat to alternative energy are the strict requirements that must be met in order to fully integrate such fuels into the military infrastructure. Each military service must first certify the use of alternative fuel blends with their tactical systems and these fuels must be able to be “dropped in” to current systems and meet standards for energy density, flash point, freezing point, thermal stability, lubricity, and viscosity (Mullen, 2011). However, the use of alternative energy sources must be synchronized with efforts to reduce consumption; otherwise there is no energy savings realized, but merely a shift from one supply source to another (Council, 2009). Only then, by seeking alternative energy technologies in combination with continued reliance on fossil fuels and conservation policies, will we reduce our foreign energy dependence (Holzman, 2006).

Finally, the 2006 JASON report, *Reducing DoD Fossil Fuel Dependence*, asserts that an energy shortage is unlikely in the near term to hinder DoD operations and emphasizes the value of optimizing the energy efficiency of weapon systems over pursuing alternative fuel at this time (Blackwell, 2007). As such, seeking alternative fuel sources that can compete with current fossil fuels such as coal and oil at a price and energy density level is extremely difficult due to the costs associated with producing and/or capturing the various types of alternative energy sources that are currently being developed or harnessed. The plain and simple truth of these ‘renewable resources’ is that they are much more expensive than state-of-the-art fossil fuel technologies and recent research has shown that some are less energy efficient and have negative environmental

impacts (Cook, 2005). Nevertheless, the U.S. has continued to invest within the alternative energy sector throughout the years as a means of continuing the development of non-petroleum based technologies. Of interest, there seems to be a certain correlation to the price of crude oil (Cushing, OK), as oil prices rise or fall, so to do investments in clean energy as seen in Figure 2.10. At the global level, clean energy has also received increased attention with growth in investments year after year, peaking at 318 billion dollars in FY2011 as depicted in Figure 2.11.

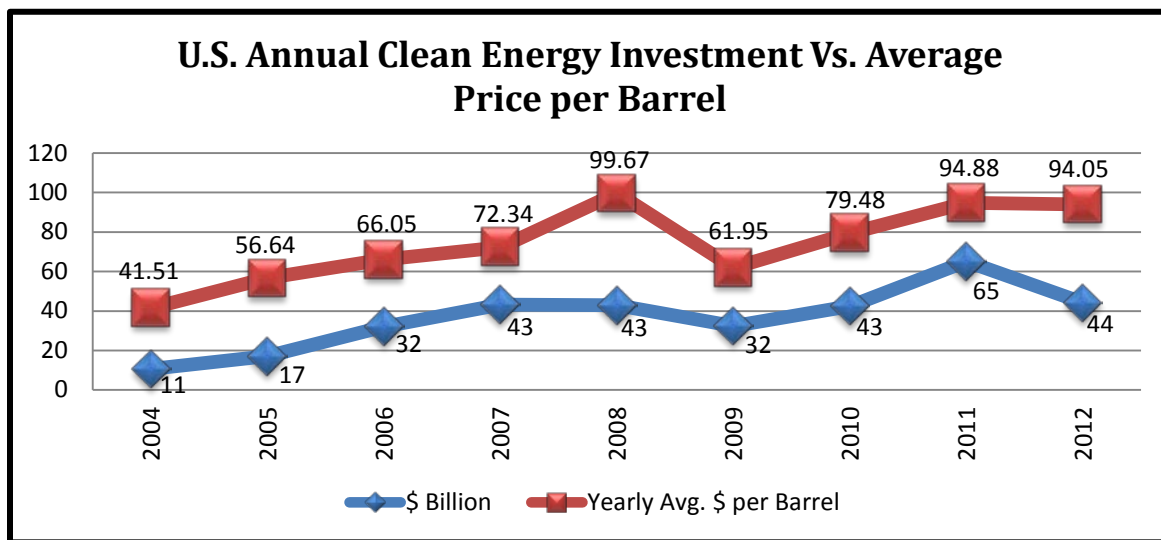


Figure 2.10 (U.S. Clean Energy Investment vs. Price per Barrel) Source: Bloomberg New Energy Finance; & EIA

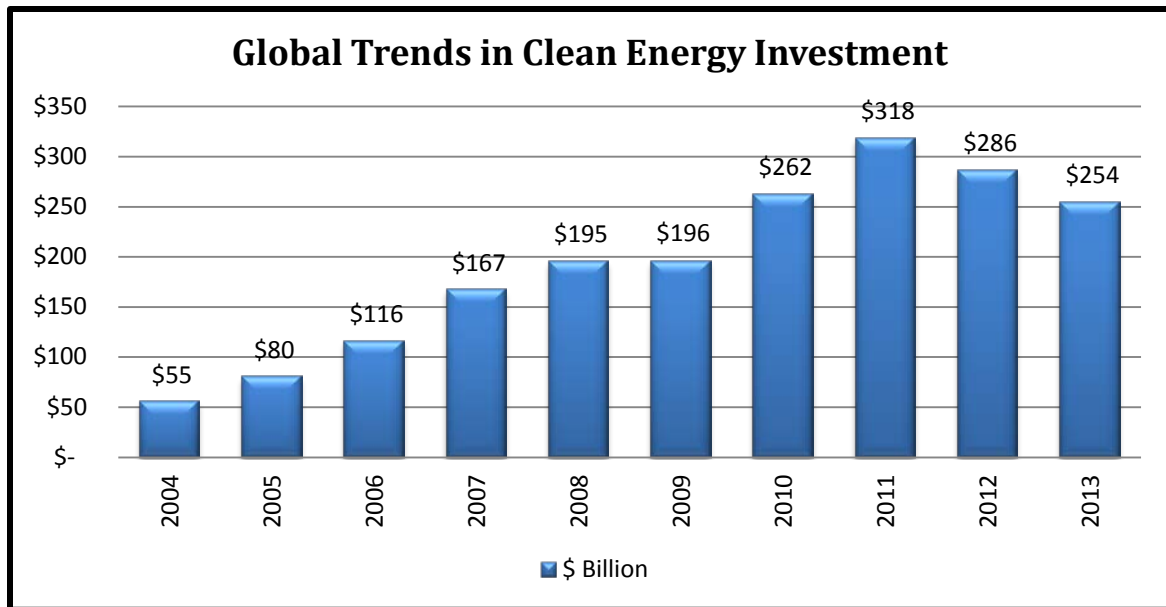


Figure 2.11 (Global Trends in Clean Energy Investment) Source: Bloomberg New Energy Finance

Installation Energy

This research study would not be complete without addressing the 4th target of the DoD Operational Energy Strategy: “*Improve Operational Energy Security at Fixed Installations*”. Even though this research is primarily focused on operational energy and its large dependency on fossil-fuel sources in order to conduct military operations around the globe, military installations are another area where substantial energy related concerns lie. According to a 2013 RAND study, DoD installations in the United States rely on the commercial electricity grid for 99 percent of their electricity needs, nearly all critical functions on installations depend on infrastructure outside DoD’s control (Samaras *et al.*, 2013). The same could apply for our foreign-based installations as well. As such, buildings and facilities account for about 25% of the Department’s total energy use (Gauntlett, 2012). Furthermore, the DoD occupies over 550,000 facilities and structures worth \$600 billion comprising more than 536 installations on more than 29.8 million acres across the globe (Williams, 2009; The Pew Charitable Trusts, 2014). This reality presents

us with real challenges in finding ways of securing the electrical power and natural gas infrastructures that power our installations as well as finding ways of circumventing power outages through the use of diesel-powered generators and renewable energy sources like: solar, hydroelectric, wave, wind, etc.

A 2008 Defense Science Board report identified four sources of risk for loss of power at installations: grid failure from overload, destruction from natural disasters, terrorist attacks and sabotage, and cyber-attacks (DSB, 2008). A 2009 CNA Military Advisory Board report found that a fragile domestic electricity grid makes our domestic military installations, and their critical infrastructure, unnecessarily vulnerable to incident, whether deliberate or accidental (CNA, 2009). A loss of energy services at an installation affects the installation's ability to perform specific mission capabilities. These missions could include: tactical unmanned aircraft systems in theater that are piloted from U.S.-based installations (Bumiller, 2012), along with the enhanced command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) capabilities supporting highly critical missions. Hence, there is overlap between what are traditionally thought of as *installation energy* and *operational energy* needs (Samaras *et al.*, 2013). This concern is noted within the *National Defense Authorization Act for Fiscal Year 2012*'s instruction to the Secretary of Defense in providing guidance for commanders of military installations inside the United States on planning measures to minimize the effects of a disruption of services by a utility that sells natural gas, water, or electric energy to those installations in the event that a disruption occurs. A number of technologies have been developed in order to reduce the likelihood of such events from occurring and to mitigate the disruption should such an event occur. Innovations such as "smart grids" which have the capability of rerouting electricity to areas where it is required the most and decreasing power output to those that require the least as well as microgrids, essentially self-contained islands of energy generation and management capacity that may or may not be attached to the commercial grid (The Pew Project, 2011), make

up the two most promising technological innovations that would help stem installation energy vulnerability to acts of terrorism and cyber-attack, natural disaster, or sabotage to the electrical infrastructure.

Not only has installation energy security been a concern to the Federal government as it seeks to reduce the consumption of all energy types used within the DoD, but specific goals have been established in order to propel us in conserving energy like the reduction of two percent every year from 2006-2015 for a 20 percent reduction in all Federal buildings according to the *Energy Policy Act of 2005* (Rozzoni, 2012). Further strengthening the abovementioned policy, EO 13423 – “*Strengthening Federal Environmental, Energy, and Transportation Management*,” signed in 2007, called for reductions of energy intensity by 30 percent by the end of FY15 relative to the FY03 baseline. These policies are important due to the fact that, according to the National Science and Technology Council (2008), buildings, at their current pace, are on track to become the largest consumer of energy in the world by 2025. With the cost of energy increasing and the world’s natural energy resources diminishing, nations across the world are placing increased emphasis on improving building energy performance (Brost, 2013). Impressively, several DoD installations are already exceeding the existing 25% renewable goal. Dyess Air Force Base (AFB) is operating 100% on renewable energy, with Minot AFB and Fairchild AFB not far behind with 95.7% and 99.6% respectively (Lengyel, 2007).

Finally, in an effort to further strengthen the previous policies, EO 13514 – *Federal Leadership in Environmental, Energy, and Economic Performance*, was signed by President Barack Obama requiring that new construction designed after 2009 is able to achieve Net Zero energy by 2030 (Order, 2009). Net Zero energy is defined by the policy as a “building that is designed, constructed, and operated to require a greatly reduced quantity of energy to operate, meet the balance of energy needs from sources of energy that do not produce greenhouse gases,

and therefore result in no net emissions of greenhouse gases and be economically viable (Order, 2009). Figure 2.12 depicts this concept.



Figure 2.12 (Net Zero Hierarchy) Source: U.S. Army Garrison Fort Detrick, MD, <http://www.detrick.army.mil/responsible/images/zerohierarchy.png>

The Reality

Although the DoD aspires to be a major player in the development of reliable sources of alternative and renewable energies as it seeks to reduce petroleum-based fuel requirements for its mighty military infrastructure and equipment. The truth is that, according to a 2006 JASON report, “DoD is not a sufficiently large customer to drive the domestic market for demand and consumption of fossil fuel alternatives, or to drive fuel and transportation technology developments, in general (Dimotakis, 2006). At present, these fuels command a price premium which is expected to decline significantly as the market develops over the next decade. However, a 2011 DoD study, *Opportunities for DoD use of Alternative and Renewable Fuels*, stated: “Despite the reduced premium, the Services’ renewable fuel goals could still impose \$2.2 billion in additional estimated annual fuel costs by 2020.” This would represent a 10 to 15 percent

increase over just conventional petroleum fuels (DoD, 2011). According to JASON, barring externalities like subsidies, governmental and departmental directives, etc., non-fossil-derived fuels are not likely to play a significant role in the next 25 years (Dimotakis, 2006). This is largely due to the high cost that alternative fuels impose compared to traditional fossil fuels which enjoy established refining and distribution networks.

As long as petroleum-based fuels are less expensive than other fuel or energy sources, this nation will continue to focus on the use of petroleum-based fuels (Council, 2009). Fossil fuels have always been—and still are—the most efficient source of energy. With their high power density and relative low cost, fossil fuels will be difficult to replace (Blackwell, 2007). The only real chance that alternative fuels have at shifting the balance in their favor, within the energy markets, is for them to become more economically competitive with fossil fuels. In a 2011 RAND report, RAND found “that a domestic alternative fuel industry could yield large economic profits within the United States. However, RAND further concluded that there was no direct benefit to the DoD or the services from using alternative fuels rather than petroleum-derived fuels (RAND, 2011). Absent a major increase in the relative reliance on alternative energy sources (which would require vast insertions of capital, dramatic changes in technology, and altered political attitudes toward nuclear energy), oil and coal will continue to drive the energy train (United States Joint Force Command, 2010). In essence, oil will leave the economic system when it becomes more expensive than alternative sources or when the end uses it satisfies disappear (Watkins, 2006).

Since the Nixon administration, America has put forth initiative after initiative to break our addiction to oil—with little success (Kraemer, 2006). The truth is that the amount of petroleum imported by the United States is so enormous that operating without it over the next several decades will be impossible for our industrialized economy (Deutch, 2005). Nevertheless,

all is not hopeless in the drive of becoming independent of foreign oil. Domestic crude oil production has increased since 2008, reversing a decline that began in 1986. From 5 million barrels per day in 2008, U.S. crude oil production increased to 6.5 million barrels per day in 2012 (EIA, 2013a). At the end of December 2013, the EIA released its *Annual Energy Outlook 2014* (AEO2014). The new outlook projects that crude oil production within the United States will approach the historical highs achieved in 1970 of 9.6 million barrels per day through 2016 (EIA, 2013b). Finally, the U.S. has decreased its imports of oil from OPEC producing countries and shifted to non-OPEC countries like Mexico and Canada located within our hemisphere as a way of mitigating its energy vulnerability (EIA, 2013a). Figure 2.13 compares U.S. crude oil production with U.S. crude oil consumption since 1980.

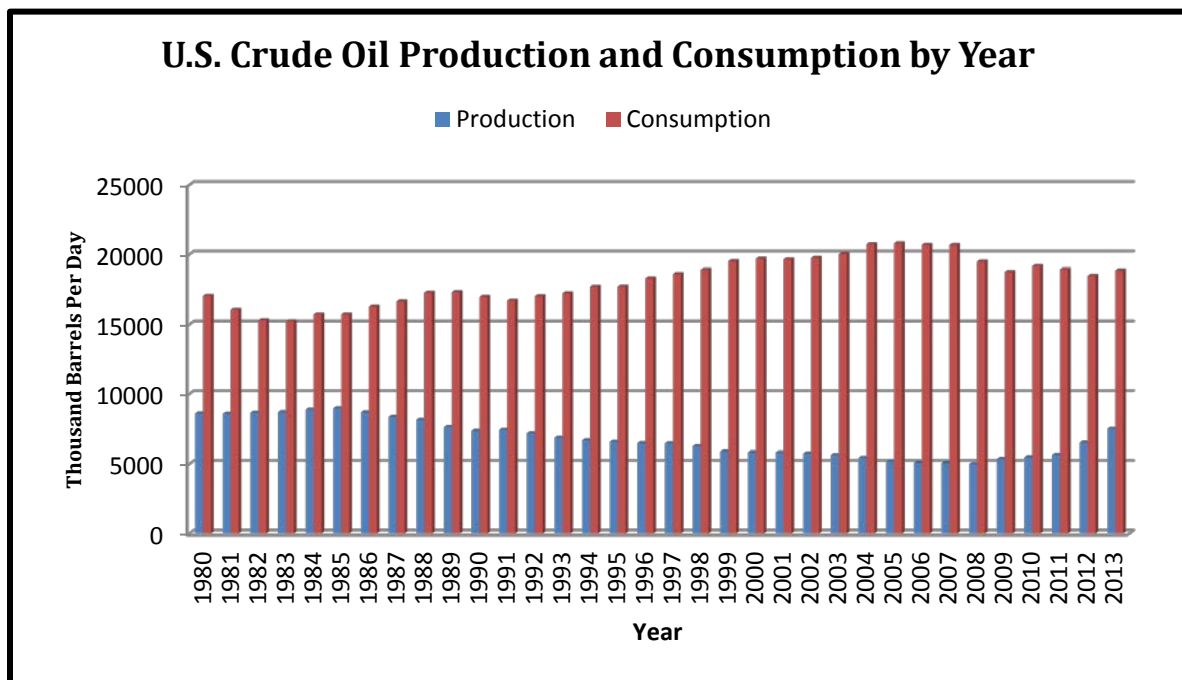


Figure 2.13 (U.S. Crude Oil Production and Consumption by Year) Source: U.S. Energy Information Administration, <http://www.indexmundi.com/energy.aspx?country=us>

Summary

There were a number of themes that seemed to constantly turn up throughout the course of the 155 documents that were analyzed in order to obtain a substantive base for our content analysis and literature review. In many cases, a broad brush was applied to our desire for energy independence resulting in recurring themes such as, the need to become more energy efficient, increasing domestic petroleum capacity and production as a means of reducing our dependence on imported oil, and continuing to fund the alternative energy technologies that are both mature and those that are futuristic. Additionally, there appeared to be a lack of a true sense of direction when it came down to identifying the appropriate mix of solutions to our energy dependency problem. The bottom line was that it would cost a tremendous amount of capital in order to reduce our dependency of foreign oil. This is due to the vast petroleum energy infrastructure that is currently in place and the fact that a high percentage of our transportation and manufacturing sectors rely primarily on combustion engine-type technologies that are powered by petroleum-based fuels.

III. Data Collection & Methodology

“Unleash us from the tether of fuel.”

—Lieutenant General James Mattis

Introduction

Chapter I presents the motivation and the research questions that guide the present study. Chapter II displays a literature review related to energy policy and provides a historical perspective of its evolution. Chapter III focuses on the study’s data collection and methodology. In it, the researcher presents the approach taken in carrying out the research project.

Data Collection

Research was conducted through the use of search engines “Google” and “Google Scholar” using subject terms “Energy Security”, “Energy Policy”, “Energy Legislation”, “Energy Strategy” and “Energy Independence”. Additionally, the online database “DTIC” was also used extensively in order to obtain many of the military research papers that were analyzed for the study. As literature was reviewed, other cited works were added dating back to 1973, including relevant studies through 2014.

Our systematic approach included a content analysis of DoD-specific energy studies and policies, both those by the Federal government and other research groups. Furthermore, independent energy studies, energy related theses and scholarly articles were also incorporated into the research.

This study was developed primarily as a content analysis of energy related material covering the 1973-2014 timeframe as it relates to the DoD Operational Energy Strategy below.

All literature was compared to the DoD Operational Energy Strategy and recorded as it matched the various “Target” areas of the strategy as listed below. At the conclusion of the literature review, a spreadsheet was used to readily identify whether or not the “Target” was referred to within the literature and a statistical analysis was performed in order to classify the existing literature and identify which topics (targets) were studied the most and which targets require further research.

DoD Operational Energy Strategy

Category I: “*More Fight, Less Fuel*” Reduce the demand for energy in military operations.

- o **Target 1:** Measure Operational Energy Consumption.
- o **Target 2:** Improve Energy Performance and Efficiency in Operations and Training.
- o **Target 3:** Promote Operational Energy Innovation.

Category II: “*More Options, Less Risk*” Expand and secure the supply of energy to military operations.

- o **Target 4:** Improve Operational Energy Security at Fixed Installations.
- o **Target 5:** Promote the Development of Alternative Fuels.

Category III: “*More Capability, Less Cost*” Build Energy security into the future force.

- o **Target 6:** Incorporate Energy Security Considerations into Requirements and Acquisition.
- o **Target 7:** Adapt Policy, Doctrine, Professional Military Education, and Combatant Command Activities (Change Culture).

Description of Data

The documents analyzed for this study consisted of government and independent reports, scholarly articles, Masters theses and research papers. The theses and research papers originated

from military schools like the Air Force Institute of Technology (AFIT), Air Command and Staff College (ACSC), and Air War College (AWC) which are part of the U.S. Air Force's Air University (AU); Joint Forces Staff College (JFSC), Naval Postgraduate School (NPS), U.S. Army War College (USAWC) and United States Marine Corps Command and Staff College (USMCCSC). All material was related to the study of energy strategy/independence from a national and military perspective.

Spreadsheet Structure

Constructing the spreadsheet was a critical part of the process. Poor structure could affect the results significantly. As such, data was classified into four main groups depending on its sources. The first group, "Government Studies, Reports & Policies", was composed of documents that were produced through governmental venues such as laws, Executive orders, or government directed studies. The second group, "Military Studies/Initiatives", was made up primarily of DoD energy reports and policy to include the four military department reports and policies. The third group, "AU Thesis/JFSC/NPS/ACSC/USAWC/AWC/USMCCSC", incorporated energy related theses and research papers published through the numerous post-graduate and intermediate Professional Military Education (PME) schools (Joint Forces Staff College, Air Command and Staff College, U.S. Army War College, Air War College and, United States Marine Corps Command and Staff College). Finally, the fourth group, "Independent", was composed of energy literature that did not fall under the first three groups. It was derived from peer-reviewed journals and independent research groups. The complete spreadsheet can be viewed in Appendix I. Scholarly articles have an asterisk in front of the author's name.

Descriptive Analysis

A descriptive analysis of the literature was instituted as a way of providing a sense to the reader of what trends the literature represented. The literature was categorized by the type of organization which produced it and year of publication. By comparing quantity of research produced with oil price fluctuations year by year, we can note trends and possible relationships between the two. This was performed to further enhance our understanding of how world events, such as increases in fuel price, might drive researchers to focus on energy related issues as topics of research. Figures 4.1 and 4.2 in Chapter IV, “Results and Analysis”, display the breakdown of the study’s findings within this area. Additionally, the main purpose of the study was to determine how the literature compared to the seven targets that make up the DoD Operational Energy Strategy. Final analysis was performed of the results in order to make inferences of the data. The results were tallied and statistical analysis was presented in order to see how the literature matched up to the targets.

Dictionary Development

The development of a dictionary is an important prerequisite to any type of content analysis (Halvorson, 2011). It is developed through the lists of words and phrases—“dictionaries” in the nomenclature of content analysis—associated with each of the content categories (targets). These words and phrases serve as indicators of the concepts of interest (Bengtson and Xu, 1995). Furthermore, due to the fact that this study was conducted without the aid of content analysis software such as QDA Miner (from Provalis Research), we proceeded with a categorization process which did not include stemming or lemmatization approaches. Both stemming and lemmatization approaches have drawbacks of significant levels; therefore, we

opted for a categorization approach as most appropriate for this type of research (Halvorson, 2011).

Stemming often reduces words to word roots and is a well-known technique of form reduction by which common suffix and sometimes prefix are stripped from the original word form, according to Peladeau and Stovall (Peladeau *et al.*, 2005). Therefore, this approach would have made it nearly impossible to interpret our results due to the fact that it could render common terms in this analysis to have completely different meanings. Lemmatization, while not as aggressive as stemming, also has its drawbacks (Halvorson, 2011).

Ambiguousness of words reduced to their root form is the most significant problem that stems from lemmatization (Halvorson, 2011). Lemmatization is “generally defined as the transformation of all inflected word forms contained in a text to their dictionary look-up form” (Boot, 1980). For example, *is*, *was*, *will be*, *am*, *are*, *were*, *being* and *been* are replaced by *be* (Krippendorff, 2013). Although lemmatization can significantly reduce word count, it can potentially create more work if researchers cannot determine the meaning of the word. Nevertheless, for the purposes of this research, reducing word count was not a requirement.

In this research, the categorization process was based on the seven targets of the *DoD Operational Energy Strategy: Implementation Plan* and proved to be relatively straightforward and free of ambiguity. The process of dictionary creation requires subject knowledge because the user will be creating categories and categorizing the words/phrases (Davis *et al.*, 2005). The content analysis enabled the identification of many core and related words within the reports, thesis, research papers and scholarly articles. The basic idea of content analysis is that the largest number of words contained in a piece of text are classified into content categories of interest (Bengtson and Xu, 1995). However, this study focused on the themes contained within the literature more than just counting the number of times a word was used. For example, if the

document promoted the development of alternative energy sources, it was recorded as having covered that specific DoD Operational Energy Strategy target. Each document could therefore contain a mixture of either zero or a combination of all seven target areas.

Categorization Process

- 1) Key words such as, “Energy Security”, “Energy Policy”, “Energy Legislation”, “Energy Strategy” and “Energy Independence”, that would return the highest search results were utilized in order to obtain energy related literature as it pertained to this study.
- 2) Material was read thoroughly and analyzed to determine if it covered any of the DoD Operational Energy Strategy targets. Target areas needed to be mentioned a minimum of one time in order to fulfill the requirement of having been discussed within the literature source.
- 3) As each piece of literature was analyzed and targets were found, a spreadsheet containing the results of covered targets was updated thereby displaying which literature works contained references to each particular target within the DoD Operational Energy Strategy and which did not.
- 4) Finally, a statistical analysis was performed thereby showing what targets received the greatest attention within the body of literature analyzed for this study.

Dictionary

- **Operational Energy:** The fiscal year (FY) 2012 National Defense Authorization Act defines “operational energy” as the energy required for training, moving, and sustaining military forces and weapon platforms for military operations (DoD, 2012d).
- **Target 1: Measure Operational Energy Consumption:** Deals with the actual documentation of energy consumption in current and planned military operations. Such measures, such as: energy metering and proactive use of fuel consumption logs fall within this category.
- **Target 2: Improve Energy Performance and Efficiency in Operations and Training:** Literature that supports the improvement of energy performance and efficiency through the use of enhanced technology that makes vehicles and military assets more efficient through the use of light composite materials, new aircraft designs that incorporate improved engines and blended wings, and powered wheels are examples of this category.

- **Target 3: Promote Operational Energy Innovation:** Operational Energy Innovation focuses on those new technologies and initiatives that are the way of the future. A few examples of these are: the use of improved lightweight batteries, powered wheels on aircraft, alternative and blended fuels, and increased use of blended wing bodies.
- **Target 4: Improve Operational Energy Security at Installations:** Literature that fit into this target provided suggestions on improving our installation's energy security through the use of smart grids, microgrids, and Net Zero initiatives as a way of increasing our resiliency in the event of a major disruption within the commercial power infrastructure.
- **Target 5: Promote Development of Alternative Fuels:** For this target, the use of alternative fuels included the use of renewable fuels/energy to include solar, nuclear, wind, hydropower as well as the conventional biofuels and their numerous derivatives. In essence, all fuels outside of the use of petroleum products were considered alternative forms of fuel/energy for this target category.
- **Target 6: Incorporate Energy Security in Requirements and Acquisitions:** We considered the incorporation of energy security in requirements and acquisition as the need to develop weapon systems with energy in mind to include the use of "Fully Burdened Cost of Energy" (FBCE) when evaluating the "Total Lifetime Cost of the Asset".
- **Target 7: Adapt Policy, Doctrine, Professional Military Education (PME), and Combatant Command Activities:** This target's central theme encompasses the need for a culture change where our personnel have a clear understanding of the current energy environment. Incorporating energy related policy and doctrine within both PME and Combatant Command activities is vital in achieving culture change within the force.

IV. Analysis and Results

“Keeping America competitive requires affordable energy. And here we have a serious problem: America is addicted to oil, which is often imported from unstable parts of the world. The best way to break this addiction is through technology.”

—President George W. Bush, State of the Union Address, 31 January 2006

Introduction

The in-depth content analysis data gathered from the accumulation of referenced materials is summarized in the following pages of this chapter. Statistical inferences are made from the qualitative analysis of the combined literature in order to answer the various investigative questions. In review, the investigative questions are as follows:

- 1) What energy related research is being performed by the DoD?
- 2) Is there a current “Master Plan” for DoD operational energy strategy research?
- 3) Is the research supporting the DoD Operational Energy Strategy?
 - a. How?
 - b. Which areas are best supported by current research?
 - c. Which areas are least supported by current research?

Big Picture

An analysis of the 155 documents that were included produced interesting results. We begin the breakdown of the analysis by viewing the number of documents that were published between 1973 and 2013. The sole document for FY2014 was left out of our initial graphs (Figures 4.1 and 4.2) due to the fact that we do not have the average crude oil spot prices for the 12 months of FY2014. However, it is incorporated within the complete analysis afterwards.

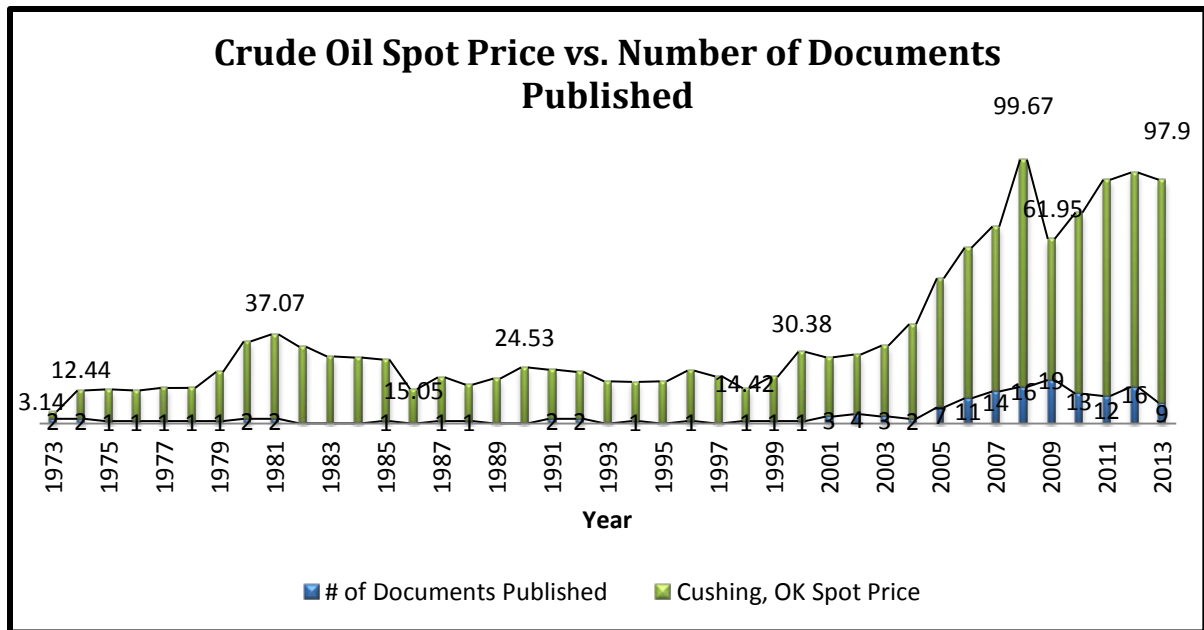


Figure 4.1 Crude Oil Spot Price vs. # of Documents Published;
Source: Earth Policy Institute from U.S. Department of Energy (DOE) & Energy Information Administration (EIA)

Note: 1970-1973 prices are the official price of Saudi Light, 1974-1985 prices are refiner acquisition costs of imported crude oil, 1986-2013 prices are spot prices for West Texas Intermediate at Cushing, OK.

As can be seen in Figure 4.1, there seems to be a trend when it comes to the rise and fall of Spot Crude Oil prices dating back to 1973 and the literature used within this study. The figure displays the average annual price of crude oil for the past forty years (1973-2013). Additionally, it displays the number of documents that were used for the content analysis and breaks them down by the year in which they were published. We note that a trend is not noticeable until after FY2000 when oil prices spiked to \$30.38 on the NYMX. As the price of oil grows, there is a noticeable trend with increased energy related publications. This trend leads us to believe that interest in energy related research follows the ebbs and flows of oil's market cost. Conceptually, as oil prices rise higher, lawmakers and researchers have an increased interest in finding solutions to our energy dependency issues through the passing of laws and performing research within the energy arena.

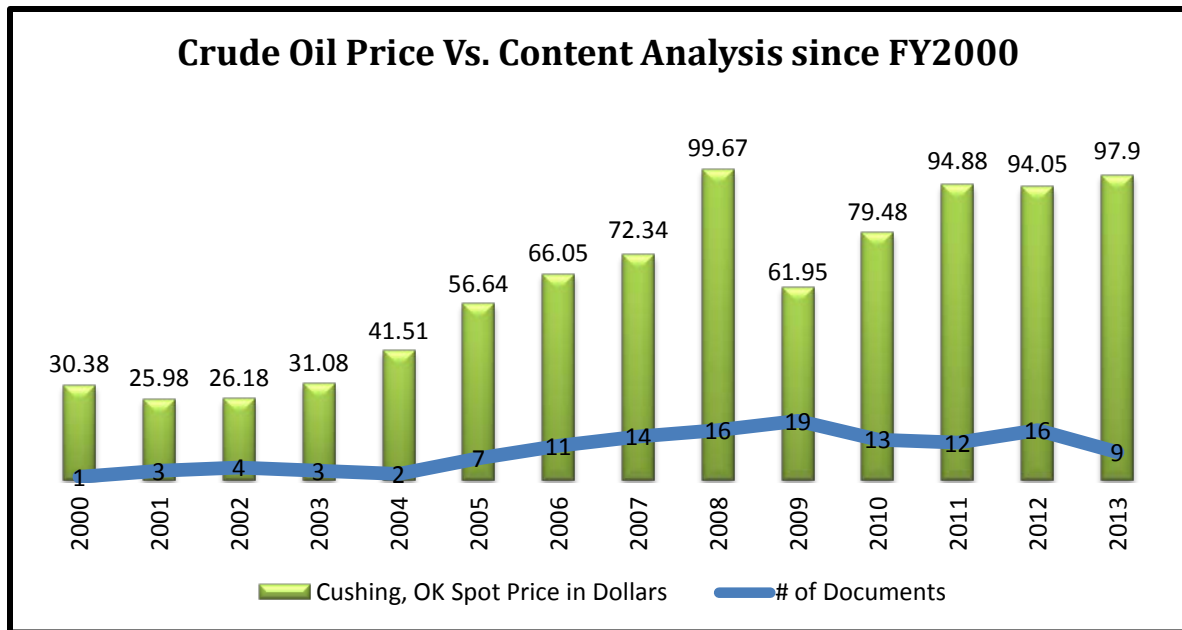


Figure 4.2 Crude Oil Price vs. Content Analysis since FY2000

Figure 4.2 provides a closer view of the last 14 years and shows the data FY2000 to FY2013. According to the chart, we note the aforementioned correlation in trends. However, of interest is the annual lag with which literature follows noticeable spikes in fuel costs. Take for instance FY2008 when the price of crude oil spiked to as much as \$145.16 per barrel on July 14, 2008. The average annual price for FY2008 was \$99.67 and there was a spike within the literature analyzed of 19 documents in FY2009. The following year, crude oil prices plummeted \$37.72 to an average annual cost of \$61.95 and our literature findings followed with only 13 documents for FY2010. This lag within the publication of energy related literature may be due to the fact that research oftentimes is reactionary to world events as well as the extended timelines and lead times it takes to publish both laws and research.

Table 4.1 Breakdown of Documents by Group

Group	Number of Documents	Percentage
Government Studies, Reports & Policies	42	27%
Military Studies/Initiatives	35	23%
AU Thesis/JFSC/NPS/ACSC/USAWC/USMCCSC	32	20%
Independent	46	30%
Grand Total	155	100%

Table 4.1 displays the data breakdown by group to include the percentage of the literature that fell into the group and Figure 4.3 presents the breakdown of groups by percentage. We are able to see that each group was composed of a relatively balanced number of documents and that no group had a disproportionate amount of documents. The group with the largest number of documents was only 10 percentage points higher than the group with the smallest number of document. This leads us to believe that no single group could disproportionately skew the final results.

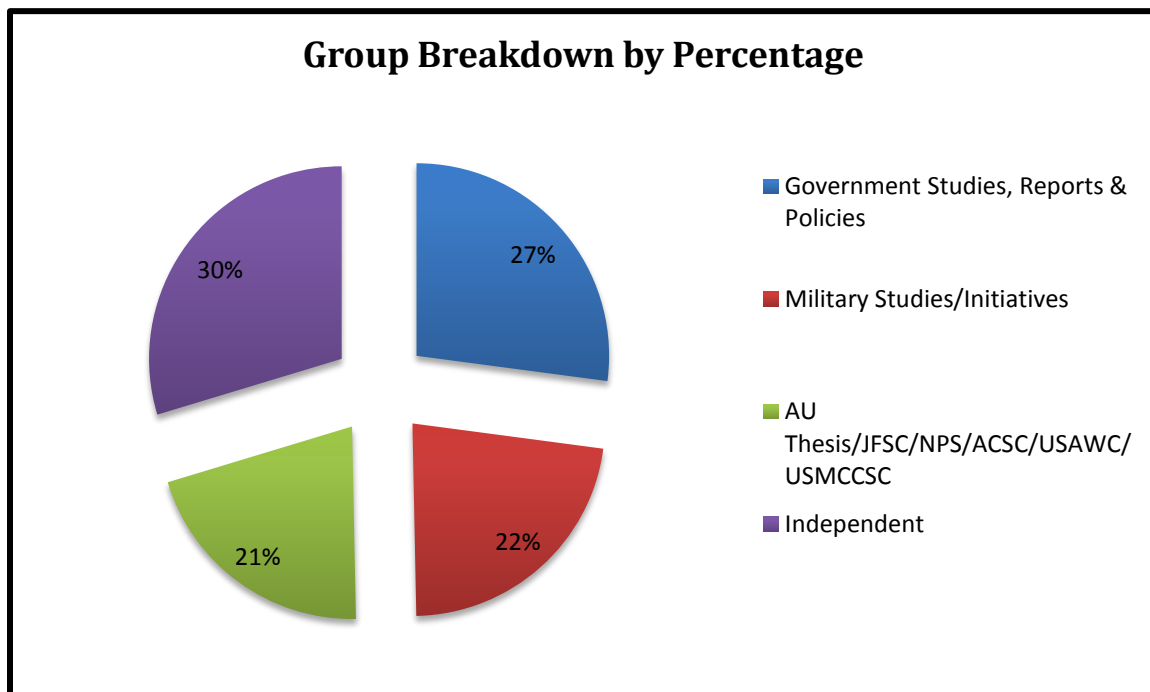


Figure 4.3 Group Breakdown by Percentage

The breakdown of the literature and number of documents is listed below in Table 4.2. The percentage represents the amount of literature that contained each specific target. All of the reports, theses, research papers, and articles were from the period 1973-2014. Further analysis of this table will be provided in the following pages.

Table 4.2 Number and Percentage of Documents by Target

Target	Description	Number of Documents	Percentage
1	Measure Operational Energy Consumption	39	25%
2	Improve Energy Performance & Efficiency	88	57%
3	Promote Operational Energy Innovation	50	32%
4	Improve Op Energy Security at Installations	29	19%
5	Promote Development of Alternative Fuels	110	71%
6	Incorporate E Security in Req's & Acquisition	31	20%
7	Adapt Policy, Doctrine, PME (Change Culture)	38	25%

We began this chapter by comparing the content analysis' literature based on publication year to the spot prices of crude oil since 1973. We followed this by presenting the breakdown of groups based on the number and percentage of documents they contain. Finally, a breakdown of the targets was provided which displayed the number and percentage of documents they were found in. We will now delve into the research's investigative questions.

Investigative Question #1: What energy related research is being performed by the DoD?

Each service within the DoD has pursued numerous options within the energy arena as a means of keeping both national and defense energy mandates and policies. The U.S. Air Force, being the largest consumer of energy within the DoD, is making strides within the arena of energy research, development, and implementation in a number of ways. As the largest purchaser of aviation fuel within the DoD, the Air Force has implemented policy measures where it is prepared to acquire 50% of its domestic aviation fuel as an alternative fuel blend by 2016 (Blackwell, 2007; The Pew Project, 2009; Blakely, 2012). Additionally, the Air Force has tested and certified many of its aircraft and systems on a 50/50 alternative fuel blend as a means of

reducing its demand for conventional petroleum fuel (JP8). Finally, it has also demonstrated national leadership in adopting renewable energy at its installations through the purchase of 5 percent of its electricity from green power sources. The Air Force is the Federal government's leading purchaser of green power electricity and ranks 7th overall in the nation (Allen, 2012) and is the only branch of the military to have met its facility energy goals (The Pew Charitable Trusts, 2014).

The U.S. Navy is the second largest consumer of energy within the DoD and plays an important role with respect to alternative energy. The Navy is currently pursuing the deployment of a "Great Green Fleet" strike group of ships and aircraft that will run entirely on alternative fuel blends by 2016. Additionally, the Navy intends to meet 50% of its total energy needs from alternative sources by 2020 (Andrews, 2012). It has certified many of its aircraft (F-18 Super Hornet, F-18 legacy Hornet, MV-22 Osprey, and MH-60 Seahawk) to operate on HRJ-5, a 50/50 blend of hydrotreated renewable fuel (HRJ) and conventional JP-5. Additionally, it has pursued innovative technological developments by installing stern flaps, which reduce drag and the energy required to propel a ship through the water and which have already generated annual fuel savings of up to \$450,000 per ship (Navy, 2009). Finally, the Navy has a lower dependence on petroleum than the other services because its aircraft carriers and submarines are nuclear-powered.

The U.S. Army is also seeking to incorporate alternative fuels into its ground mission and has been researching their viability. The Army has been testing 50/50 blends of Fischer-Tropsch synthetic paraffinic kerosene and HRJ with JP-8 for use in all Army ground systems and field generators, with the goal of certifying these fuels by 2014 (DoD, 2011). Additionally, similar to the U.S. Marine Corps, the Army has focused many of their efforts on enhancing their soldier's capability to power and recharge electronic devices and batteries while in the field through the

use of innovations in solar powered equipment. Finally, the Army has also focused its efforts on making its generators more efficient and researching lighter composite materials for the use within its ground vehicles as a way to reduce its fuel requirement.

Of the four branches of service, the U.S. Marine Corps consumes the least energy due to their unique mission and size of force. Nevertheless, they too are proactively seeking ways by which to contribute to the research that is being performed within the DoD. Their focus areas lie mostly with changing the way their personnel employ energy in order to increase combat effectiveness resulting in a reduction of logistics support ashore (Wise, 2013). The use of a number of photovoltaic (PV) dependent systems such as the Solar Portable Alternative Communications Energy System (SPACES) which has the capacity to power various tactical radios and personnel electronics while in the field, as well as, the Ground Renewable Expeditionary Energy Network System (GREENS) for a larger sized force such as a platoon, provides additional power capacity for field personnel. Finally, the Marines are making bare bases more energy efficient through the use of tent liners like the Radiant Barrier Blanket (RBB)². It provides an additional layer of insulation resulting in an increased insulation factor which enables the reduced consumption of generator use thereby reducing fuel consumption on the installation.

A complete list of the Service's fuel efficiency technologies and initiatives as discovered through the course of this study can be found in Appendix II. Overall, the DoD energy research is headed in the right direction. The services are focusing on their key competencies and trying to maximize energy efficiency through innovation and ingenuity based on available resources and funding.

Investigative Question #2: Is there a current “Master Plan” for DoD operational energy strategy research?

Based on the substantial literature review performed during this research covering the timeframe 1973-2014, there is no single document that displays a “Master Plan” for performing DoD energy research. However, this study has made an effort to fill this gap by mapping the research landscape in order to enable us to work toward this master plan. We now have a clear and objective picture of what research exists and of which direction we are headed.

Investigative Question #3: Is the research supporting the DoD Operational Energy Strategy?

Yes, the content analysis that was conducted during this study is proof that the current research does support the DoD Operational Energy Strategy in a number of ways. All seven targets of the DoD Operational Energy Strategy were found to varying extents within the literature that was analyzed. Some targets received a higher amount of attention than others and will be further analyzed in the next few pages.

a. How? (How is the research supporting the DoD Operational Energy Strategy?)

The breakdown of the seven DoD Operational Energy Strategy targets presented interesting results to the researcher. Each of the seven targets was discussed to some degree within the majority of the literature that was analyzed. Figure 4.4 shows the number of documents that mentioned the various seven targets based on subject terms used (covered within the Data Collection and Methodology of Chapter III).

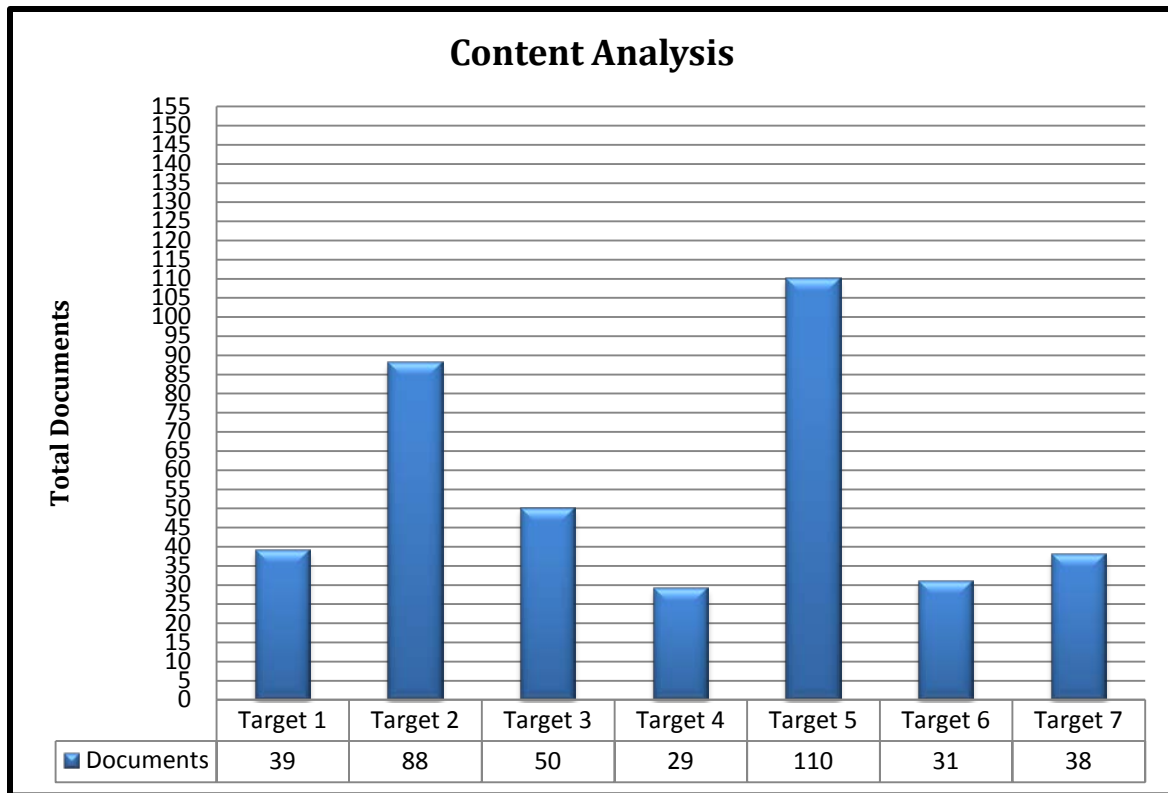


Figure 4.4 Content Analysis Results Broken Down by Target;

Key: T1: Measure Operational Energy Consumption; T2: Improve E Performance and Efficiency; T3: Promote Operational Energy Innovation; T4: Improve Operational Energy Security at Installations; T5: Promote Development of Alt Fuels; T6: Incorporate Energy Security Considerations in Requirements and Acquisition; T7: Change Culture

Interestingly enough, 15% of the 155 energy documents analyzed contained no mention of any of the seven DoD Operational Energy Strategy targets and 25% of the documents only focused on one of the seven targets. A further breakdown of the quantity of targets covered within the literature per document is displayed in Figure 4.5.

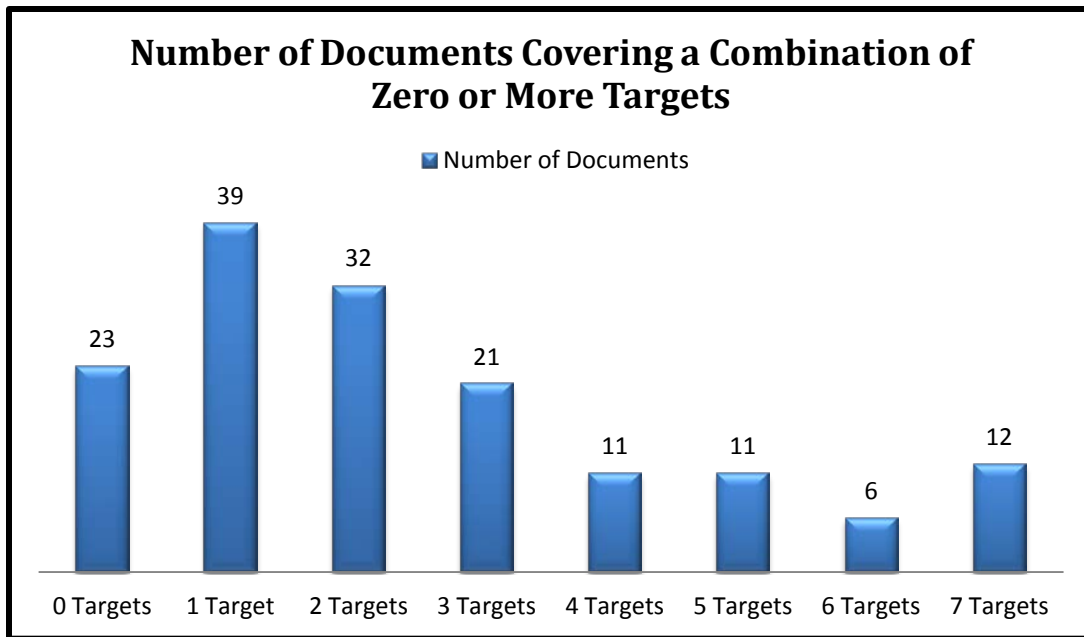


Figure 4.5 Number of Documents Covering a Combination of Zero or More Targets

Figure 4.5 reveals the number of documents which contained either zero or a combination of one to all seven targets. As one would expect, most documents contain the mention of a single DoD Operational Energy Strategy target. This may be due to the fact that researchers sought to keep a narrow focus on one aspect of energy research in order to keep their study manageable. At the other end, we noted that 12 documents contained all seven targets. As should be expected, these documents were made up primarily of publications that originated from DoD and military departments as they addressed the DoD Operational Energy Strategy within their policies.

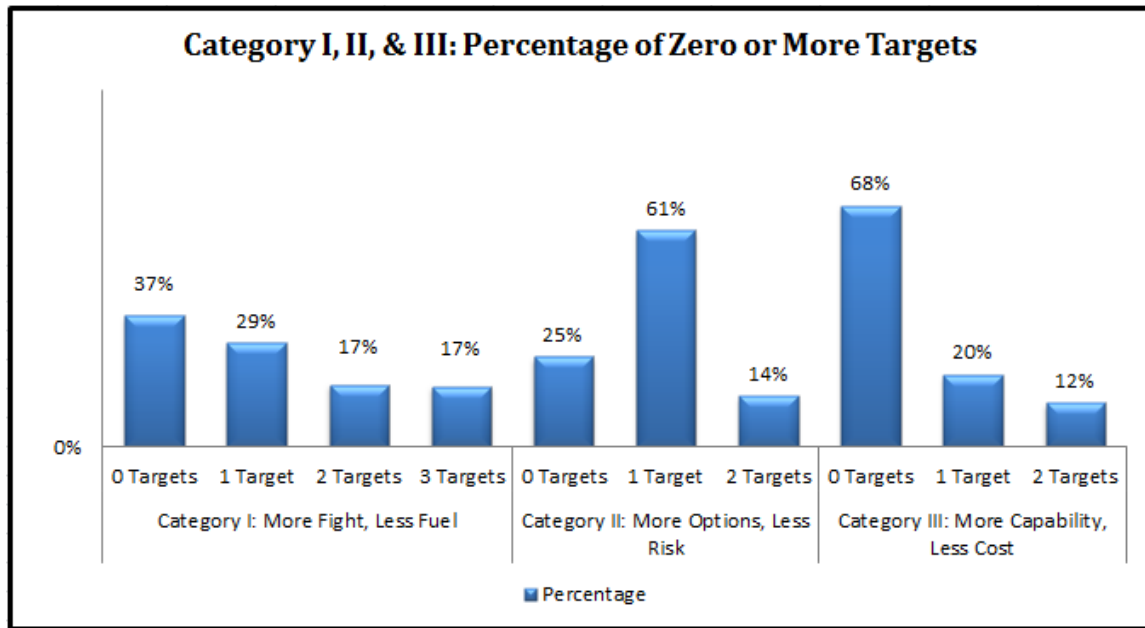


Figure 4.6 Category I, II, & III: Percentage of Zero or More Targets

Figure 4.6 provides a visual representation of the three main categories that make up the DoD Operational Energy Strategy. Category I: “*More Fight, Less Fuel*” bears the first three targets “*T1: Measure Operational Energy Consumption; T2: Improve Energy Performance and Efficiency; and T3: Promote Operational Energy Innovation*”. Category II: “*More Options, Less Risk*” contains both Targets 4 and 5 “*T4: Improve Operational Energy Security at Installations and T5: Promote Development of Alternative Fuels*” while Category III: “*More Capability, Less Cost*” bears the last two “*T6: Incorporate Energy Security Considerations in Requirements and Acquisition, and T7: Adapt Policy, Doctrine, Professional Military Education, and Combatant Command Activities*”. Category II: “*More Options, Less Risk*” contained the highest percentage of discussion within the literature having been found within 75% of the 155 documents analyzed. 25% or 39 documents of 155 contained no mention of any of the two Category II targets. The targets within Category I: “*More Fight, Less Fuel*” were discussed within 64% of the documents while Category III: “*More Capability, Less Cost*” received the least amount of attention having only been found within 32% of the study’s documents. In other words, 105 of the study’s 155

documents contained no mention of Category III targets making it the least discussed category of the DoD Operational Energy Strategy within the literature. A more detailed breakdown will be discussed using Figure 4.7.

b. Which areas are best supported by current research?

Looking back at Figure 4.4, the reader can clearly see that Target 5 “*Promote Development of Alternative Fuels*”, was found within 110 of the 155 documents that made up the study. This accounts for a 71% mention rate within the documents. Additionally, Target 2 “*Improve Energy Performance and Efficiency*” was discussed within 57% of the documents having been found in 88 of the 155 documents. These two targets received a disproportionate amount of research within the 155 documents that made up the content analysis and were the areas best supported by current research. Target 5 may have received the highest percentage of mention within the content analysis due to the amount of attention it’s been given since the Arab Oil embargo in 1973. On the other hand, Target 2 presents the greatest opportunity of reducing our consumption of fossil fuels through the development of more energy efficient engines. Engines today are more energy efficient and have better performance than they did year ago. However, researchers believe there is still much to be gained within this area.

The next area that received a fair share of support within the literature, but not as great as the first two, was Target 3 “*Promote Operational Energy Innovation*”. It was covered within 32% of the 155 documents analyzed for the study. Although Target 3 ranked third in terms of discussion within the literature, it represents an area in which the sky is the limit and where we’re only limited by our imagination and technological abilities. We can all think of innovative ways of reducing our energy consumption both at home station and while deployed such as switching off lights not in use, turning down/up the thermostats depending on the season, and limiting engine idle times. Additionally, innovative energy technologies can go a long way into relieving

our dependency of all types of energy sources. This same principle can be applied to the use of innovative building designs that incorporate energy savings into all parts of the process.

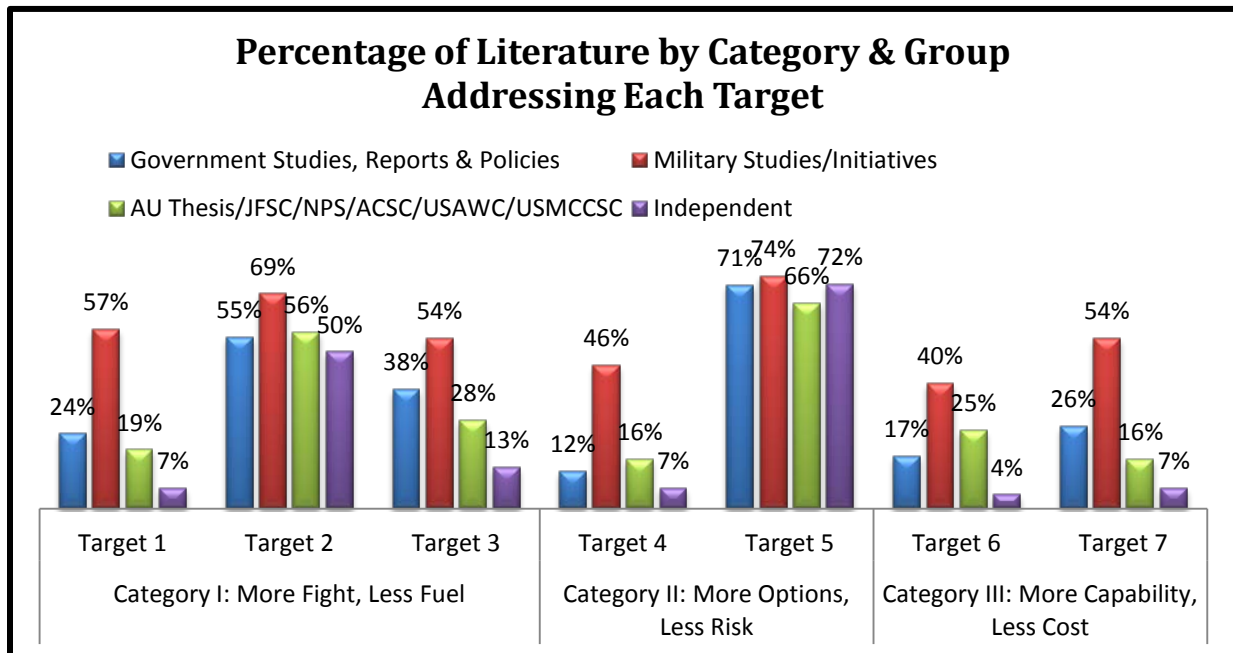


Figure 4.7 Percentage of Literature by Category & Group Addressing Each Target

Key: T1: Measure Operational Energy Consumption; T2: Improve E Performance and Efficiency; T3: Promote Operational Energy Innovation; T4: Improve Operational Energy Security at Installations; T5: Promote Development of Alt Fuels; T6: Incorporate Energy Security Considerations in Requirements and Acquisition; T7: Change Culture

Figure 4.7 displays the percentages of literature, by category (*Category I: More Fight, Less Fuel*; *Category II: More Options, Less Risk*; *Category III: More Capability, Less Cost*) and group (*Government Studies, Reports & Policies*; *Military Studies/Initiatives*; *AU Thesis...*; and *Independent*), covering each target within the content analysis. As the reader can see, Target 5 “Promote Development of Alternative Fuels” confirms earlier results as discussed in Investigative Question 3(b), “Which areas are best supported by energy research?” It is the most covered topic within the three DoD Operational Energy Strategy categories and is well represented by all four groups of the literature ranging from 66% to 74%. It further demonstrates that the development

of alternative fuels represents a big piece within energy related literature since the 1970s. Target 2 “*Improve Energy Performance and Efficiency*” was the second most discussed target within the literature bearing a 50% to 69% mention within the four groups. We may be able to attribute this to the fact that energy researchers find this target area within reach of current technological advancements and one that has the greatest chance of putting a dent into our dependence of fossil fuels.

What is of interest is that the *Military Studies/Initiatives* group provided a much greater representation of the other DoD Operational Energy Strategy target areas than the other three groups that made up the study. This is primarily due to the fact that the DoD Operational Energy Strategy originates directly from the DoD level and filters down to the military departments. These departments, all of whom make up the group, have published policies that support the targets of the DoD Operational Energy Strategy further driving the increased mention of these lesser researched areas.

Of all the targets covered by the *Military Studies/Initiatives* group, the target area least covered by the literature was Target 6 “*Incorporating Energy Security in Requirements and Acquisitions*” nevertheless; it still garnered a respectable 40% mention within the group’s literature. This is primarily a direct result of congressional mandates that direct the DoD to take such factors as the FBCE into account as it relates to its acquisition processes.

The literature results within the *Independent* group provided the greatest disparity within the target areas. The literature within the group focuses primarily on two targets and makes very little mention of the other five DoD Operational Energy Strategy targets. 72% of the group’s literature focused on Target 5, “*Promote Development of Alternative Fuels*” and 50% of the *Independent* group’s literature discussed Target 2, “*Improve Energy Performance and Efficiency*”. In other words, research on improving performance and efficiencies was discussed

in 23 of the 46 articles and promoting the development of alternative fuels was covered in 33 of the 46 articles that made up the group. These results were to be expected due to the fact that many researchers may be unaware of the DoD Operational Energy Strategy. As a result, their areas of focus will be primarily directed to areas that do not pertain to energy as it relates to military installations, operations or the acquisition process. Nevertheless, independent researchers could be served well by directing their efforts into other less researched areas based on this analysis.

c. Which areas are least supported by current research?

Based on the 155 documents analyzed for this study, there were some noticeable gaps between the DoD's Operational Energy Strategy and current research. Again, looking back at Figure 4.4, we see that some targets received less attention by researchers within the study's literature. Target 4 "*Improve Operational Energy at Installations*" was only found within 29 of the 155 documents which represents a 19% discussion rate. Target 6 "*Incorporate Energy Security Considerations in Requirements and Acquisition*" saw only a 1% increase at 20% having been discussed within 31 of the 155 documents. This is to be expected, due to the fact that a portion of the documents that composed this study, originated from non-military sources. Many researchers may be unaware of the unique energy challenges the DoD and military departments are confronted with. However, these two target areas should receive additional research attention in order to close the gap that exists between those targets that received a high percentage of discussion within the literature and those that did not. Future researchers should focus their efforts on increasing the knowledge base within these target areas in order to find viable solutions to our energy dilemma.

V. Conclusions and Recommendations

“We cannot keep going from shock to trance on the issue of energy security, rushing to propose action when gas prices rise, then hitting the snooze button when they fall again. The United States of America cannot afford to bet our long-term prosperity and security on a resource that will eventually run out.”

—President Barack Obama, 30 March 2011

Introduction

This chapter finalizes the effort of this research. First, the research objectives are revisited in an effort of ensuring that the requirements have been met. Second, the effort’s research significance is discussed as a means of presenting future energy researchers with ways in which the study can be incorporated in facilitating their research. Finally, additional discussion bullets are provided and various recommendations for future research are presented.

Research Conclusion

Throughout the years, much has been written concerning our nation’s reliance on foreign energy sources. This study presents a wide array of examples as they relate to energy as found within literature covering the past 40 years. From Executive orders, to Congressional mandates as well as military policy both at the DoD and service levels, down to thesis research performed by members of the various military branches and finally, the inclusion of independent researchers working for commercial research agencies or published within peer-reviewed journals, this study sought to present a balanced understanding of the major issues that plague our energy independence resolve.

Being a major consumer of energy within the Federal government, the DoD plays a key role in shaping how our military departments view and engage energy related issues and problems. As such, as discussed through the study, it has developed the DoD Operational Energy Strategy in order to provide the departments with a sense of direction as it relates to energy. The

seven *DoD Operational Energy Strategy: Implementation Plan* targets were an integral part of this study. They were the central piece around which the content analysis of the 155 documents studied was performed. They provided the structure against which documents were compared and analyzed and which permitted the answering of the study's investigative questions. We will briefly restate the questions.

Investigative Question #1: What energy related research is being performed by the DoD?

We noted that all military departments have engaged energy related research in one fashion or another. Each one has focused on energy research related to their primary energy usage requirements. The U.S. Air Force has focused its attention on ensuring its aircraft are certified to fly on a 50/50 fuel blend and has led the way with improving its installation energy requirements through a number of ways such as through the use of solar panels and microgrids. The U.S. Navy has demonstrated its commitment by investing in many innovative energy technologies as can be seen in Appendix II and through the continued development of the "Great Green Fleet" and certifying many of its air assets to run on a 50/50 fuel blend as well. Both the U.S. Army and U.S. Marine Corps, being the military departments that specialize in ground combat and movement, have focused their efforts on enhancing their power generation in the field through numerous innovative solar powered technologies as well as seeking ways to lighten the weight of their military assets while at the same time maintaining or increasing current safety measures through the use of lightweight composite materials.

The measures the DoD has put in place, as a result of the Federal government's legislative actions within the energy arena, seem to be paying off. The military departments have focused their efforts appropriately within their core competencies in an effort to meet the DoD Operational Energy Strategy. There is still a long road ahead towards reducing our dependency on fossil fuels, but all four branches of the military have demonstrated initiative in pursuing more

efficient energy technologies and incorporating an increased energy awareness mind frame in operational planning and the procurement of military weapon systems.

Investigative Question #2: Is there a current “Master Plan” for DoD operational energy strategy research? No, based on the number of documents that were analyzed, none was found within the literature. This may be due to the fact that the study’s literature was composed of a wide array of documents ranging from Federal laws and military policy to scholarly articles that either used a broad brush when talking about operational energy or focused on only a single aspect of energy. Nevertheless, an effort was made, during this study, to fill this gap by mapping the research landscape. This should enable future researchers to work toward this master plan provided by a clear and objective picture of what research exists and a general direction where we are headed.

Investigative Question #3: Is the research supporting the DoD Operational Energy Strategy? Yes, the research did support all seven target areas at different levels. We noted the varying degrees with which each target of the DoD Operational Energy Strategy was presented within the literature.

3a) How? Of the 155 documents analyzed for the study, 85% covered one or more targets. It was an expectation of this study to find that a great portion of the literature would cover one or more of the seven DoD Operational Energy Strategy targets. This was further cemented based on the type of search that was performed when seeking energy related documents and the wide net that was utilized wherein much of the energy related literature spanning the past 40 years was incorporated within this study.

3b) Which areas are best supported by current research? Both Targets 5 and 2 received the greatest attention within the literature. Target 5 dealt with promoting the development of

alternative fuels and garnered a 71% rate of discussion among the 155 documents, while Target 2, which dealt with energy performance and efficiency, was discussed within 57% of the documents that made up the content analysis. There is little to no confusion why these two targets attained the first and second place within the content analysis. For many years now, alternative fuels have become a hot issue for the United States and abroad as countries seek to diversify their sources of energy. Being that there are a myriad of alternative energy sources, it's no wonder that the literature contains so many articles that seek to study and promote them based on their merits. The same can be said about Target 2 "*Improve Energy Performance and Efficiency*", researchers find this topic as the one that is within our grasp. Based on the technological and engineering improvements we've seen within the energy field in the last few decades, lawmakers and researchers know that this is the surest way of decreasing our dependence of all fuels—especially carbon-based ones.

3c) Which areas are least supported by current research? Both Target 4 "*Improve Operational Energy at Installations*" and Target 6 "*Incorporate Energy Security Considerations in Requirements and Acquisition*" were the least supported by current research at only a 19 and 20 percent respectively within the literature analyzed. These results were not surprising based on the fact that these two target areas have not been hot topics in the media. For one, installation energy is received from the public electrical grid which is powered primarily via coal, natural gas, hydroelectric, and/or nuclear depending on the installation's location. With very few exceptions, primarily due to natural disasters, there have not been substantial or long-term installation energy issues that would raise awareness within this target area. Nevertheless, it has garnered the attention of military leaders and researchers due to the increased vulnerability our installations have to severe weather, power blackouts/brownouts, sabotage, cyber-attacks or terrorist acts that could disrupt our military command and control capabilities during a mission planning or

humanitarian/disaster event. Target 6, on the other hand, has not gained the attention it deserved based on the long-standing low cost of fuel we've enjoyed for so long. It hasn't made its way into the literature until recently when the cost of fuel has skyrocketed leading many military planners and analysts to see it as a way of the future within the requisition and acquisition planning arena. As such, the literature is skewed wherein only two of our study's groups (Military Studies/Initiatives; and AU Thesis....) mention it within over 25% of the group's literature.

Research Significance

The significance of this research can be had in the fact that it sought to incorporate energy related literature over the span of the last 40 years. It not only includes independent research and research performed within the various military postgraduate and intermediate PME schools, but also incorporates Congressional mandates, Executive orders and both DoD and military department policies and reports. The 155 documents that were discovered were filtered through the DoD Operational Energy Strategy lens in order to determine which of the seven DoD Operational Energy Strategy implementation targets were discussed within them. Based on the wide array of documents analyzed, this approach had never been undertaken. As such, future researchers will be able to utilize this study as they pursue their research within any one of the seven DoD Operational Energy Strategies. Through the use of the content analysis spreadsheet located in Appendix I, researchers will readily see which areas were covered by the numerous documents that made up this study and will enable them to incorporate stated documents into their research.

Additional Discussion

The following is a list of additional discussion items that were not a core part of this study's purpose but that could be beneficial to any future energy related research.

- Congress needs to continue to fund energy innovation and development efforts at appropriate levels in order to further technological advancements and gain ground within the energy arena.
- We must bear in mind that the incorporation of alternative fuels within the military structure will likely increase the complexity of the supply chain in having to find new ways of providing those fuel sources to the field compared to the established supply chains we currently use in the distribution of legacy fuels like JP-8, JP-5, diesel, and gasoline.
- Despite all our efforts to become energy independent from foreign sources of fuel, some researchers believe that rapid price changes could occur and would affect the U.S. even if the U.S. did not import any oil from the Middle East (Delucchi *et al.*, 1996; Stocking, 2012) “so long as domestic suppliers of energy can participate in these [world-oil] markets, as domestic suppliers of the affected energy sources divert their supplies to foreign markets and as suppliers of substitute energy sources do the same” (Makinen, 1991).
- Energy independence has been a hot topic since the 1970s and has garnered much attention by researchers and politicians as a strategy that would shield the U.S. from potential recessions triggered by rapid increases in oil prices, however, CRS points out, “the only way to prevent this sequence of events from occurring would be to completely isolate the U.S. from foreign markets” (Makinen, 1991).
- Achieving 100% fuel independence may not be a realistic goal for the DoD for the foreseeable future. But a dedicated DoD leader, focused on a roadmap for the department that is part of a comprehensive plan for the United States, can achieve reasonable goals that are good for the DoD, good for the Warfighter, and good for the nation (Blackwell, 2007).

Recommendations for Future Research

Recommendation 1: This study found that through the span of the past 40 years, much has been written within the energy literature as it relates to promoting the development of

alternative energy and increasing asset performance and efficiencies. However, other target areas of the DoD Operational Energy Strategy did not receive as much attention within the literature. Future research would be beneficial in strengthening the research depth within those target areas that received the least mention within the literature. Target areas such as Target 4 “*Improve Operational Energy Security at Installations*”, Target 6 “*Incorporate Energy Security Considerations in Requirements and Acquisitions*”, and Target 7 “*Adapt Policy, Doctrine, Professional Military Education, and Combatant Command Activities*” would be served well by receiving additional attention by researchers due to the importance they have in further promoting a solution to our energy dilemma.

Recommendation 2: One of the many things that was discovered through the course of this study was the preponderance of calls for energy independence from foreign energy sources of petroleum by U.S. presidents and lawmakers, military analysts and independent researchers. What was not found, but with very few exceptions, was a deep analysis into the second and third-order effects this move would have on the U.S. We know that two oil wells in the Gulf of Mexico could produce enough oil to fill the DoD’s needs, but we do not know exactly how this would affect our place in the world or what geopolitical effects it would have. Further research within this area would be beneficial and would demonstrate if true energy independence is truly as good as it sounds.

Recommendation 3: Lastly, due to the time constraints of this research and the amount of documents that were thoroughly analyzed, time did not permit the researcher to gain deeper insight or validation from experts within the field of energy. Future researchers would be served well by furthering stated research with the use of Delphi groups, surveys and current expert opinion in order to strengthen the parameters as they relate to this study.

Summary

There is no doubt that we will continue to struggle with energy dependency from foreign energy sources for the perceivable future, but we are making headway within the energy arena through numerous energy initiatives, mandates, and investments. New technologies ranging from fuel efficient engines to improved vehicle/vessel designs that are aerodynamic are available to all modes of transportation and must be leveraged if we're to make a substantial impact into the consumption of global fossil fuels. Additionally, the U.S. must continue to invest in a variety of alternative fuels to include clean fuels derived from coal—one of our country's largest natural resources. Global suppliers should continue to increase oil production capacity in order to avoid future crude oil shortages due to growing global energy demands. Finally, changing a culture that considers energy cheap and abundant is one of the most difficult challenges facing the Department and the nation (DSB, 2008). The only way we'll be able to gain ground within the energy conservation arena as we try to reduce our dependency on all sources of energy, whether foreign or domestic, will be by implementing a myriad of approaches beginning with the acceptance that each of us has a role in helping to reduce our use and dependency of energy. By first admitting that we have an energy problem and by seeking ways to lessen our demands of both the electrical and fossil fuel networks, we can all do our part in minimizing our requirements of stated energy sources. Obviously, in order for such a proposal to pay off, our culture's belief of "cheap and plentiful energy" must change. We will only win when the masses internalize the reality of the energy situation the world finds itself in, and actively participates in eliminating unnecessary energy usage. If not, we will continue to go down the path towards increasing energy dependency, exhaustion of our world's natural resources, and increased pollution of our environment.

Appendix I: Content Analysis

Key: T1: Measure Operational Energy Consumption; T2: Improve E Performance and Efficiency; T3: Promote Operational Energy Innovation; T4: Improve Operational Energy Security at Installations; T5: Promote Development of Alt Fuels; T6: Incorporate Energy Security Considerations in Requirements and Acquisition; T7: Change Culture

	Author(s)	Content Analysis Literature	T1	T2	T3	T4	T5	T6	T7	
Government Studies, Reports & Policies	Nixon, R. (1973)	Address to the Nation About National Energy Policy								0
	U.S. Congress (1974)	Energy Supply and Environmental Coordination Act of 1974, Public Law 93-319						X		1
	U.S. Congress (1974)	Federal Energy Administration Act of 1974		X						1
	U.S. Congress (1975)	The Energy Policy and Conservation Act of 1975		X						1
	Carter, J. (1977)	The President's Proposed Energy Plan					X			1
	Carter, J. (1979)	Crisis of Confidence					X			1
	U.S. Congress (1980)	Energy Security Act of 1980					X			1
	Reagan, R. (1981)	Executive Order 12287-Decontrol of Crude Oil and Refined Petroleum Products								0
	Reagan, R. (1981)	Message to the Congress Transmitting the National Energy Policy			X					1
	Carnes, J. (1987)	Department of Defense Directive: Defense Energy Information System (DEIS)	X						X	2
	U.S. Congress (1988)	Alternative Motor Fuels Act of 1988					X			1
	Bush, H.W. (1991)	State of the Union Address		X			X			2
	Assistant Secretary of Defense (Production and Logistics) (1991)	Department of Defense Instruction: Energy Management Policy	X	X		X	X	X	X	6
	U.S. Congress (1992)	Energy Policy Act of 1992 (EPACT92) Public Law 102-486	X	X	X		X	X	X	6
	U.S. Congress (1992)	National Energy Conservation Policy. 42 USC Chapter 91	X	X	X		X		X	5
	Fehner, T., and Hall, J. (1994)	Department of Energy 1977-1994: A Summary History								0
	Clinton, W. (1999)	Executive Order 13123: Greening the Government Through Efficient Energy Management		X	X		X	X	X	5
	Bush, G. W. (2001)	National Energy Policy: Report of the National Energy Policy Development Group		X	X		X		X	4
	U.S. Congress (2002)	Energy Policy Act of 2002		X			X			2
	Bush, G.H. (2003)	State of the Union Address			X		X			2
	Energy Information Administration (2005)	International Energy Outlook 2005								0
	U.S. Congress (2005)	Energy Policy Act of 2005 (EPAct 2005) Public Law 109-58	X		X		X			3

	Gallis, P. (2006)	NATO and Energy Security								0
	Truths, H. (2007)	Facing the Hard Truths about Energy		X	X		X			3
	Found, W. G. (2007)	Uncertainty about Future Oil Supply Makes It Important to Develop a Strategy for Addressing a Peak and Decline in Oil Production					X			1
	U.S. Congress (2007)	Energy Independence and Security Act (EISA) of 2007	X	X	X		X			4
	Bush, G. W. (2007)	Executive Order 13423: Strengthening Federal Environmental, Energy, and Transportation Management		X			X		X	3
	Sissine, F. (2007)	Energy Independence and Security Act of 2007: A Summary of Major Provisions		X			X			2
	Center for a New American Security (CNAS) (2008)	A Strategy for American Power: Energy, Climate and National Security		X	X				X	3
	U.S. Congress (2009)	Duncan Hunter National Defense Authorization Act for Fiscal Year 2009	X		X	X	X	X		5
	CNA Military Advisory Board Contributing Authors (2009)	Powering America's Defense: Energy and the Risks to National Security		X	X	X			X	4
	Order, E. (2009)	Executive Order 13514: Federal Leadership In Environmental, Energy, and Economic Performance		X			X			2
	Obama, B. (2009)	Blueprint For A Secure Energy Future		X	X		X			3
	Congressional Research Service (2011)	A Navy Biofuel Initiative Under the Defense Production Act					X			1
	U.S. Congress (2011)	Energy Performance Goals and Master Plan for the Department of Defense. 10 USC 2911	X	X	X	X	X	X	X	7
	U.S. Congress (2011)	A Roadmap for America's Energy Future					X			1
	Stocking, A. (2012)	Energy Security in the United States		X			X			2
	U.S. Congress (2012)	Energy Policy and Conservation Act (EPCA) Public Law 94-163	X	X	X		X			4
	The White House (2012)	The Blueprint For A Secure Energy Future: Progress Report		X	X		X			3
	U.S. Congress (2012)	National Defense Authorization Act for Fiscal Year 2012	X	X		X	X	X	X	6
	Energy Information Administration (2013)	Annual Energy Outlook 2013 with Projections to 2040					X			1
	Congressional Research Service (2013)	Renewable Energy and Energy Efficiency Incentives: A Summary of Federal Programs		X			X			2
Military Studies/Initiatives	Deputy Assistant Secretary of Defense (1980)	Defense Energy Management Plan		X	X		X		X	4
	National Defense University (2000)	Joint Vision 2020: America's Military--Preparing for Tomorrow								0
	Truly, R. H., & Alm, A. L. (2001)	Report of the Defense Science Board on More Capable Warfighting through Reduced Fuel Burden	X	X	X			X		4
	Deputy Secretary of Defense (2004)	Department of Defense Directive: DoD Management Policy for Energy Commodities and Related Services	X			X	X			3
	Dimotakis, P., Grober, R., & Lewis, N. (2006)	Reducing DoD Fossil-Fuel Dependence	X	X	X		X			4

Crowley et al. (2007)	Transforming The Way DoD Looks At Energy: An Approach to Establishing Energy Strategy	X	X	X	X	X	X	X	X	7
Director of Plans and Programs (2008)	DoD Energy Security Task Force	X	X	X		X		X		5
Defense Science Board (2008)	"More Fight - Less Fuel," Report of the Defense Science Board Task Force on DoD Energy Strategy	X	X	X	X	X	X	X	X	7
Donley, M. (2008)	Air Force Policy Memorandum 10-1	X	X	X	X	X	X	X	X	7
U.S. Marine Corps (2008)	Marine Corps Vision & Strategy 2025									0
Dept. of the Army (2009)	Tactical Fuel and Energy Strategy for the Future Modular Force (Final Draft)	X	X	X		X		X		5
Council, A. S. E. the Office of the Deputy Assistant Secretary of the Army for Energy and Partnerships (2009)	Army Energy Security Implementation Strategy		X			X		X		3
U.S. Army Training and Doctrine Command (2009)	The Army Capstone Concept Operational Adaptability: Operating under Conditions of Uncertainty and Complexity in an Era of Persistent Conflict 2016-2028		X			X				2
Andrews, A. (2009)	Department of Defense Fuel Spending, Supply, Acquisition, and Policy (CRS 7-5700)						X			1
Congressional Research Service (2010)	Quadrennial Defense Review 2010: Overview and Implications for National Security Planning		X		X	X				3
Donley, M. (2010)	Air Force Energy Plan 2010	X	X	X	X	X	X	X	X	7
Dept. of the Navy (2010)	A Navy Energy Vision for the 21st Century	X	X	X	X	X	X	X	X	7
Meyer, J., & Talley, R. (2010)	Tactical Fuel and Energy Implementation Plan	X	X			X		X		4
United States Joint Force Command (2010)	Joint Operating Environment (JOE)					X				1
U.S. Marine Corps (2011)	United States Marine Corps Expeditionary Energy Strategy and Implementation Plan "Based-To-Battlefield"	X	X	X	X			X		5
Assistant Secretary of Defense for Operational Energy, Plans & Programs (2011)	Department of Defense Energy for the Warfighter: Operational Energy Strategy	X	X	X	X	X	X	X	X	7
Deputy Secretary of Defense (2011)	Department of Defense Directive: Assistant Secretary of Defense for Operational Energy Plans and Programs (ASD(OEPP))									0
Mullen, M. G (2011)	The National Military Strategy of the United States of America, 2011: Redefining America's Military Leadership									0
Department of Defense (2011)	Opportunities for DoD use of Alternative and Renewable Fuels					X				1
Schwartz, M., Blakeley, K., and O'Rourke, R. (2012)	Department of Defense Energy Initiatives: Background and Issues for Congress (CRS 7-5700)	X	X	X	X	X	X	X	X	7

	Assistant Secretary of Defense for Operational Energy Plans & Programs (2012)	Department of Defense Operational Energy Strategy: Implementation Plan	X	X	X	X	X	X	X	7
	Assistant Secretary of Defense for Operational Energy Plans & Programs (2012)	Department of Defense: Energy Investment for Military Operations: For Fiscal Year 2013	X	X	X	X	X	X	X	7
	Congressional Research Service (2012)	DoD Alternative Fuels: Policy, Initiatives and Legislative Activity					X			1
	Department of Defense (2012)	Strategic Sustainability Performance Plan FY 2012	X	X	X	X	X	X		6
	Dept. of the Navy (2012)	Naval Air Systems Command Energy Strategy	X	X	X	X	X	X	X	7
	Loechl, P., Kemme, M., Shah, P., and Goran, W. (2012)	Resource Efficiency in the US Army Corps of Engineers: Examination of Strategies To Reduce Energy Use and Greenhouse Gas Emissions	X		X		X			3
	Samaras, C., & Willis, H. H. (2013)	Capabilities-Based Planning for Energy Security at Department of Defense Installations				X				1
	Donley, M. and Welsh III, M. (2013)	U.S. Air Force Energy Strategic Plan	X	X	X	X	X		X	6
	Wise, M. (2013)	Guide to Employing Renewable Energy and Energy Efficient Technologies (X-File 4-11.61xx)		X			X		X	3
	Witt III, R. and Larson, C. (2013)	Fully Burdened Cost of energy Analysis: A Model For Marine Corps Systems (Thesis)		X				X	X	3
AU Thesis/JFSC/NPS/ACSC/USAWC/USMCCSC	Watkins, G. (2006)	Oil scarcity: What have the past three decades revealed?								0
	Kraemer, T. (2006)	Addicted to Oil: Strategic Implications of American Oil Policy		X			X			2
	Tewksbury, D. (2006)	Preemptive Energy Security: An Aggressive Approach to Meeting America's Requirements								0
	Holzman, S. (2006)	A Need For Change: The Looming Energy Crisis					X			1
	Hornitscheck, M. (2006)	War Without Oil: A Catalyst For True Transformation		X	X	X	X	X		5
	Gallant, R. (2006)	Petroleum Independence: A Business Case and Strategy		X			X			2
	Peck, B. (2006)	The U.S. Strategic Petroleum Reserve: Needed Changes to Counter Today's Threats to Energy Security								0
	Czarnik, J. (2007)	US Oil Dependency—The New Weapon of Mass Disruption					X			1
	Custer, J. (2007)	Algae: America's Pathway to Independence					X			1
	Blackwell, K (2007)	Department of Defense and Energy Independence: Optimism Meets Reality	X	X			X	X		4
	Lengyel, G. (2007)	Department of Defense Energy Strategy Teaching An Old Dog New Tricks	X	X	X	X	X		X	6
	Vann, L. (2008)	Feasibility of JP-8 To Jet A Fuel Conversion At U.S. Military Facilities					X			1
	Wagner, J. and Singer, P.W. (2008)	Fueling the "Balance" A Defense Energy Strategy Primer	X	X	X	X	X	X	X	7
	Corley, R. (2009)	Evaluating The Impact Of The Fully Burdened Cost of Fuel						X		1

	Fields, G. (2009)	Alternative Energy and Propulsion Power for Today's U.S. Military	X	X	X		X	X		5
	Black, C. (2009)	Post Oil America and a Renewable Energy Policy leads to the Abrogation of the Middle East to China		X			X			2
	Haigh, C. (2009)	Getting Over The Barrel--Achieving Independence From Foreign Oil in 2018		X			X			2
	Scofield, J. (2009)	Energy Security Through 2030: Some Considerations 2009		X	X		X			3
	Bennett, C. (2009)	Middle Eastern Energy Security: Synchronizing Domestic and Foreign Policy		X	X		X			3
	Williams, D. (2009)	Energy Security and National Security; Securing U.S. Energy Resources	X	X		X	X	X		5
	Farrell, M. (2009)	Tough Guys Go Green: Expanding DoD's Role in Energy Security					X	X		2
	Grana, B. (2010)	Incentivizing Sustained Department of Defense Energy Efficiency through a Modified Appropriations Framework	X	X			X	X	X	5
	Weaver, R. (2010)	Gasoline: The Achilles Heel of U.S. Energy Security		X			X			2
	Toydas, M. (2010)	Fuel Savings Opportunities from Air Refueling		X	X		X			3
	Stein, F. (2011)	Ending America's Energy Insecurity: How Electric Vehicles Can Drive The Solution To Energy Independence								0
	Linck, S. (2011)	Tanker Fuel Consolidation: Impact of Fuel Efficiency on ATO Resiliency			X					1
	Halvorson, E. (2011)	A Century Long Pursuit of Alternative Fuels and Feedstocks: A Content Analysis					X			1
	Rozzoni, J. (2012)	Analysis of Leadership in Energy and Environmental Design Construction in the Air Force				X				1
	Allen, S. (2012)	Cultural Change and the Operational Energy Strategy		X					X	2
	Brost, G. (2013)	Successfully Implementing Net-Zero Energy Policy through the Air Force Military Construction Program		X						1
	Blumberg, G. (2013)	The Origin of the Department of the Navy's Biofuel Initiative and the Volatility Problem for Defense Energy								0
	Gerber, C. and Clark, J. (2013)	More Fight-Less Fuel: Reducing Fuel Burn Through Ground Process Improvement		X	X				X	3
Independent	*Wilson, C. (1973)	A Plan for Energy Independence								0
	*Lovins, A. B. (1976)	Energy Strategy: The Road Not Taken?		X			X		X	3
	*Cox, J. & Wright, A. (1978)	The Effects of Crude Oil Price Controls, Entitlements and Taxes on Refined Product Prices and Energy Independence								0
	*Goldemberg, J., Johansson, T., Reddy, A., & Williams, R. (1985)	An End-Use Oriented Global Energy Strategy		X			X			2
	Delucchi, M. & Murphy, J. (1996)	U.S. Military Expenditures to Protect the Use of Persian-Gulf Oil for Motor Vehicles								0
	Campbell, C and Laherrere, J. (1998)	The End of Cheap Oil					X			1
	Morse, E. L. (2001)	Strategy Energy Policy Challenges for the 21st Century		X			X			2

*Taylor, J. & VanDoren, P. (2002)	Evaluating the Case for Renewable Energy: Is Government Support Warranted?					X			1
Coon, C. & Phillips, J. (2002)	Strengthening National Energy Security by Reducing Dependence on Imported Oil								0
Tomam, M. (2002)	International Oil Security: Problems and Policies		X			X			2
*Wirth, T., Gray, B., & Podesta, J. (2003)	The Future of Energy Policy		X			X			2
Klare, M. (2003)	The Bush-Cheney Energy Strategy: Implications for U.S. Foreign and Military Policy		X	X		X			3
Klare, M. (2004)	Bush-Cheney Energy Strategy: Procuring the Rest of the World's Oil			X					1
*Hirsch, R., Bzdek, R. & Wendling, R. (2005)	Peaking Oil Production: Sooner Rather Than Later?		X			X			2
Cook, B. (2005)	Energy Policy: "A Clear and Present Danger?"					X			1
Goodstein, D. (2005)	Out of Gas: The End of the Age of Oil		X			X			2
*Lackner, K. & Sachs, J. (2005)	A Robust Strategy for Sustainable Energy		X			X			2
Collina, T. (2005)	Oil Dependence and U.S. Foreign Policy: Real Dangers, Realistic Solutions		X			X			2
Nygren, D., Massie, D. & Kern, P. (2006)	Army Energy Strategy for the End of Cheap Oil	X	X			X	X	X	5
Yergin, D. (2006)	Ensuring Energy Security					X			1
*Verrastro, F. & Ladislav, S. (2007)	Providing Energy Security in an Interdependent World		X			X			2
Fisher, B. & Macheret, Y. (2007)	Should DoD be Concerned with Potential Petroleum Supply Shortage and What Could It Do to Stimulate Alternative Fuels Development?					X			1
Cohen, A. (2007)	The National Security Consequences of Oil Dependency					X			1
*Pierce, R. (2007)	Energy Independence and Global Warming								0
Bryce, R. (2008)	Gusher of Lies: The Dangerous Delusions of "Energy Independence"								0
*Shinnar, R. & Citro, F. (2008)	Decarbonization: Achieving Near-Total Energy Independence and Near-Total Elimination of Greenhouse Emissions with Available Technologies		X			X			2
Nivola, P. (2008)	Rethinking "Energy Independence"					X			1
*Blumenthal, D. (2008)	Concerns with Respect to China's Energy Policy								0
MacKay, D. (2008)	Sustainable Energy—Without the Hot Air		X	X		X			3
*Weidenmier, M. (2008)	Is Sugar Sweeter at the Pump? The Macroeconomic Impact of Brazil's Alternative Energy Program					X			1
*Halff, A. (2008)	Energy Nationalism, Consumer Style: How the Quest for "Energy Independence" Undermines U.S. Ethanol Policy and Energy Security					X			1
*Potter, N. (2008)	How Brazil Achieved Energy Independence and the Lessons the United States Should Learn from Brazil's Experience					X			1

	Alexander, L. (2008)	A New Manhattan Project for Clean Energy Independence					X			1
	Bryce, R. (2009)	Energy Security Means Energy Interdependence								0
	Stein, S. (2009)	Energy Independence Isn't Very Green		X			X			2
	Bisk, T. (2009)	A Realistic Energy Strategy					X			1
	Powers, J. (2010)	Oil Addiction: Fueling Our Enemies		X			X			2
	*Miller, G. (2010)	The Security Costs of Energy Independence			X		X			2
	Doerry, N., McCoy, T., and Martin, T. (2010)	Energy and the Affordable Future Fleet								0
	Rosen, M. (2010)	Energy Independence and Climate Change: The Economic and National Security Consequences of Failing to Act		X			X			2
	Lovins, A. B. (2010)	DoD's Energy Challenge as Strategic Opportunity	X	X		X				3
	The Pew Project (2011)	From Barracks to the Battlefield: Clean Energy Innovation and America's Armed Forces		X	X	X	X			4
	Martin, T. and Levac, T. (2012)	Green Ships Bringing the Green Machine to the Fight: How a New Concept Small Deck Amphibious Ship Can Enhance the US Navy Energy Security Posture	X	X	X			X		4
	Krauss, C. & Lipton, E. (2012)	U.S. Inches Toward Goal of Energy Independence		X			X			2
	Gauntlett, D. (2012)	Renewable Energy for Military Applications		X			X			2
	The Pew Charitable Trusts. (2014)	Power Surge: How the Department of Defense Leverages Private Resources to Enhance Energy Security and Save Money on U.S. Military Bases		X		X			X	3
Total:			39	88	50	29	110	31	38	

Appendix II: Fuel Efficiency Technologies/Initiatives

	Fuel Efficiency Technologies/Initiatives	Year	Source
Air Force	Blended Wing Body	2008	More Fight-Less Fuel
	Variable Speed Tilt Rotor	2008	More Fight-Less Fuel
	Versatile Affordable Advanced Turbine Engine (VAATE)	2008	More Fight-Less Fuel
	Lightweight Composite Materials	2008	More Fight-Less Fuel
	Multimegawatt Electric Power Systems (MEPS)	2008	More Fight-Less Fuel
	Powered Wheels	2008	More Fight-Less Fuel
	Unmanned Vehicles (UAVs, UGVs, UUVs)	2008	More Fight-Less Fuel
	Adaptive Versatile Engine Technology program (ADVENT)	2011	From Barracks to the Battlefield
	Highly Efficient Embedded Turbine Engine (HEETE)	2011	From Barracks to the Battlefield
Army	"Blast Bucket" Light Armored Ground Vehicle	2008	More Fight-Less Fuel
	Improved batteries and lightweight, portable, collapsible solar collectors for recharging batteries	2008	More Fight-Less Fuel
	Ground Source Geothermal Cooling at FOBs	2008	More Fight-Less Fuel
	Fresh Water at FOBs (Water Wells)	2008	More Fight-Less Fuel
	Efficient Generators	2008	More Fight-Less Fuel
Navy	First amphibious assault ship with an electric Auxiliary propulsion	2009	A Navy Energy Vision for the 21st Century
	Tested the full envelope of an F/A-18, including supersonic flight, on a jet fuel blend of petroleum-based fuel and "drop-in" biofuel	2010	A Navy Energy Vision for the 21st Century
	Introduction of an "energy dashboard" on maritime platforms to monitor power and fuel consumption.	2010	A Navy Energy Vision for the 21st Century
	Nuclear powered aircraft carriers and submarine fleets	Multiple Years	A Navy Energy Vision for the 21st Century
	Increasing use of training simulators	Multiple Years	A Navy Energy Vision for the 21st Century

	F/A-18 aircraft operating at more higher and efficient altitudes saving \$250,000 in annual fuel	Multiple Years	A Navy Energy Vision for the 21st Century
	Improved compressor and turbine designs, performance-seeking controls, and advanced materials are under development	Multiple Years	A Navy Energy Vision for the 21st Century
	Procurement of more efficient and generator-integrated environmental control units	Multiple Years	A Navy Energy Vision for the 21st Century
	Development of alternative power generation systems, including on-board vehicle power generation and renewable energy systems (roll-out solar panels and solar lighting)	Multiple Years	A Navy Energy Vision for the 21st Century
	Installation smart grid with long-range vision of full integration into a national smart grid	Multiple Years	A Navy Energy Vision for the 21st Century
	Advanced Solid State Lighting (SSL): uses Light Emitting Diode based lighting fixtures to replace conventional fluorescent and incandescent light fixtures. LED lights require about 25% of the power of an equivalent incandescent bulb with a service life of roughly 35 to 50 times as long.	Multiple Years	Energy and the Affordable Future Fleet
	Improved Directional Stability: ships that are not directionally stable require significant rudder action to maintain course thus adding to the ship's drag and thereby increasing fuel consumption.	2011	Energy and the Affordable Future Fleet
	Propeller redesign: it is now possible to design acoustically quiet propellers with efficiencies better than what was achievable when many surface ships were originally designed.	2011	Energy and the Affordable Future Fleet
	Hull and Propeller Coatings: These smooth finishes offer less resistance when new and are resistant to fouling because marine life have difficulty adhering to it. Commercial ships have experienced an average reduction in fuel consumption on the order of 9%.	2009	Energy and the Affordable Future Fleet
	Stern Flaps: is an extension of the hull bottom surface aft of the transom. Stern flaps modify the flow of water under the hull afterbody, decreasing flow velocity and increasing pressure, resulting in reduced form drag, and thus reduced hull resistance.	Multiple Years	Energy and the Affordable Future Fleet
	Bulbous Bows are a bulb extending in front of the ship's stem designed to create a wave that cancels the ship's bow wave.	Multiple Years	Energy and the Affordable Future Fleet

Marines	Solar Portable Alternative Communication Energy System (SPACES) (flexible solar panel) used to recharge radio batteries and provide on demand power for tactical radio.	Multiple Years	USMC Expeditionary Energy Strategy and Implementation Plan
	Ground Renewable Expeditionary Energy Network System (GREENS) can harvest energy in less than ideal conditions and has an array of energy storage banks.	Multiple Years	Guide to Employing Renewable Energy
	Radiant Barrier Blanket (RDD) ² Creates an additional thermal barrier, increasing the shelter's insulation factor.	Multiple Years	Guide to Employing Renewable Energy

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Vita

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His first assignment was to Yokota AB, Japan as a Logistics Readiness Officer where he served as the OIC of Distribution, Combat Mobility Flight, and Vehicle Management Flight Commander in the 374th Logistics Readiness Squadron. Additionally, he served as the installation's Honor Guard Flight Commander until his departure in August 2012.

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