ENERGY

ABSTRACT: Energy, a leverage industry, is the lifeblood of a nation's economy. It fuels all other industries and provides the backbone of a nation's ability to wield its economic, diplomatic, informational and military instruments of power. Ensuring the security of America's energy resources is complicated due to our dependence on foreign fuel sources, environmental and political obstacles within the US and a limited surge capability to counteract geopolitical realities. As our domestic production of energy resources decreases, projected increases in economic growth will drive increases in energy demand that can currently only be met through imports. Additionally, inconsistent deregulation of the electricity industry caused some instability of the electric market that was highlighted by California's electricity crisis in 2000-2001. These realities make policies—those that promote diversity in fuel types and sources, incentivize new transport technologies and guarantee a future stable and reliable electric system—the cornerstone for energy security. We found that the energy industry is not yet in crisis; however, new US government policies, laws and financing must be enacted and improved public awareness pursued to increase energy security.

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PLACES VISITED:

Domestic: All locations are in the United States

Location	Company	Business
Ft. Belvoir, VA	Defense Energy Support Center	Energy supply and distribution for DOD
Alexandria, VA	H2Gen	Hydrogen generation
Frederick, MD	BP Solar	Photovoltaic panel manufacturing
Baltimore, MD	Wheelabrator Resco Plant	Combined heat and power generation
Washington, DC	Department of Energy	Pipelines, National Energy Policy, hydrogen fuel cells
Langley, VA	CIA Headquarters	Oil industry analysis
Bethesda, MD	Potomac Electric Power Company	Electricity power distribution
Peach Bottom, PA	Peach Bottom Nuclear Power Plant	Electricity power generation
San Ramon, CA	Chevron/Texaco	Oil and natural gas
San Francisco, CA	Pacific Gas & Electric Company	Electricity power distribution
Middletown, CA	Calpine Corporation "The Geysers" Geothermal Project	Geothermal electricity generation
Sacramento CA	California Energy Commission	Energy policy/legislation
Livermore, CA	Green Ridge Services' Livermore Operations Center	Wind powered electricity generation
Sacramento, CA	Folsom Dam – Bureau of Reclamation	Hydro-electric power generation and flood control
West Sacramento, CA	California Fuel Cell Partnership	Automotive application of H2 fuel cell technology

International:

Location	Company	Business
Norway		
Oslo	Ministry of Finance, Ministry of Petroleum and Energy, Ministry of Foreign Affairs	Government Policy
Oslo	Norsk Hydro	Hydro-electric power generation
Stavanger	Statoil and Snøhvit LNG Project	Oil and natural gas production
Oslo	Institute for Energy Technology (IFE)	International research center for nuclear and energy technology
Oslo	Nord Pool, Nordic Power Exchange	International commodity exchange for electrical power

Iceland		
Reykjavík	Icelandic New Energy	Hydrogen generation and fuel cell research.
Reykjavík	Ministry for Foreign Affairs	Iceland's Security and Defense Policy
Reykjavík	Landsvirkjun, the National Power Company	Electricity generation and distribution
Nesjavellir	Nesjavellir Geothermal Power Plant	Geo-thermal electricity generation
Búrfell	Búrfell Hydro Power Station	Hydro-electric power generation
Ireland		
Dublin	Sustainable Energy Ireland (SEI)	Government energy policy
Dublin	Edenderry Power (peat-fired plant)	Electricity generation
Dublin	Fingleton White and Company, LTD	Electric power and heat generation for Guinness Brewery
Dublin	Business Briefing: Airtricity, University College Dublin, SEI	Government policy and economics

INTRODUCTION

The US is the world's largest consumer and net importer of energy, ranking twelfth worldwide in oil reserves, sixth in natural gas and first in coal.[i] As the lifeblood of our economy, energy is vitally important to our national security. Following the oil shortage, Arab oil embargo and invasion of Afghanistan by the Soviet Union in the 1970s, President Carter declared access to Persian Gulf oil a vital national interest during his 1980 State of the Union address.[ii] Likewise, the 14 August 2003 electricity blackout affecting large parts of the Midwest, Northeast, and Canada highlighted the vulnerability of our the national power grid and demonstrated how a disruption in the supply of energy can significantly impact not only the quality of our lives, but also our economic well-being.

This paper summarizes the findings from our semester-long study of the energy industry. We begin by providing an overview of the industry. Next, we look at specific trends and challenges facing the various industry sectors. We then discuss the role of government and provide some specific policy recommendations. Finally, we examine three major energy issues in expanded essay format and then offer conclusions. Our analysis, recommendations and conclusions were developed from lectures by industry experts, readings, independent research and insights gained from both domestic and international travel to Norway, Iceland and Ireland.

THE INDUSTRY DEFINED

Establishment of a continued reliable and secure energy supply is essential to our national security. Despite technological advances that have improved energy efficiency and reduced our energy intensity (energy use per dollar of GDP) by 45% since the 1970s, America's demand for energy is still the largest globally at 24% of the world's consumption. The US consumed over 97 quadrillion British Thermal Units (QBtu) of the 404 QBtus consumed around the world in 2002—more than twice as much as the next closest country, China, which used 40.4 QBtu.[iii] To

sustain this large demand, in 2002, the US was required to import 4 trillion cubic feet of natural gas (about 18% of its total consumption) as well as 11.2 million barrels per day of oil (56.1% of total consumption).[iv] Without more deliberate efforts to reduce our dependence, America's reliance on energy imports is projected to continue to grow from 26% of total consumption today to 36% in 2025.[v]

The industry consists of four end-user sectors. The largest energy user is the industrial sector, which uses one third of the total energy, followed by transportation, 28%; residential, 21%; and commercial, 18%. Transcending all sectors and accounting for the vast majority of industry's demand, electricity generation accounts for about 40% of our nation's energy demand.[vi] Thus, *electricity generation* and *transportation* are the major focus areas of our energy usage. Energy resources to meet these needs are comprised of fossil fuels, including coal, oil and natural gas; nuclear power; and green or clean sources, such as hydro, geothermal, solar and wind. The following section on current conditions highlights the trends and challenges facing the industry.

CURRENT CONDITIONS (Electricity Generation and Transportation)

As a general overview, electricity generation is provided primarily through coal, nuclear and natural gas power plants, but the contributions of renewable energy sources also play an essential role in diversifying the US energy portfolio. The most significant issues in this industry are the recent deregulation initiatives, which affect company decisions regarding the construction of new generation plants and transmission lines, and the influence of clean air legislation on generation type. As for transportation, our reliance on imports of fossil fuels and the inevitable depletion of this resource can only be countered through a concerted effort to establish a hydrogen (or similar) economy.

Electricity Generation

According to forecasters, and as indicated in the President's May 2001 *National Energy Policy*, electricity demand in the US is expected to grow by almost 50% (390,000 MW) by the year 2020. In addition to efforts that increase energy efficiency and curb demand, we must increase power generation and transmission capability. To elaborate, the government estimates that we will have to build between 1,300 and 1,900 new power plants or more than one power plant per week for the next 16 years to meet demand.[vii] Although costly, establishing the proper portfolio of generation plant types and improving the reliability of the grid system are both essential to our national security.

Natural Gas: In its report titled *Annual Energy Outlook 2004*, the Energy Information Administration (EIA) estimates that natural gas consumption within the US will increase by nearly 40% between 2004 and 2025. The EIA also estimates that natural gas consumption could be between 32 and 35 trillion cubic feet (Tcf) per year by 2020. Much of this increase will result from an increase in reliance on natural gas-fired electricity generation plants expected to come online to meet the nation's rising demand for electricity. Furthermore, because of the relatively low capital requirements for building natural gas-fired combined cycle generation plants, as well as the reduction of emissions that can be earned from using natural gas, the EIA expects 88% of new electric generation capacity built by 2020 will be natural gas combined-cycle or combustion turbine generation.[viii]

Trends and Challenges

Several factors are driving the trend in increased reliance on natural gas for electricity generation. Natural gas electricity generation plants offer flexibility in sizing with generation capacity ranging from large-scale generation plants down to small-scale micro turbines. With this flexibility, shorter construction lead times and lower capital investment costs, natural gas electricity generation plants provide an economic and timely means of providing incremental increases in generation capacity. Environmental concerns are also driving this trend. Finally, these plants can be turned on and off very quickly, thereby making them the preferred choice in adjusting to variations between base and peak loads throughout the day, which can differ by as much as 46%.[ix]

The natural gas industry faces two significant challenges: (1) ensuring that adequate liquefied natural gas (LNG) facilities are constructed so that significant quantities of LNG can be imported from outside North America and (2) ensuring over the next two decades that adequate pipeline capacity is available. Currently, the US interstate and intrastate natural gas distribution system is not adequate to meet projected increases in demand. Interstate pipeline companies have roughly 270,000 miles of pipeline delivering approximately 22.6 Tcf of natural gas annually from processing plants to local distribution companies (LDCs). LDCs currently own approximately 952,000 miles of pipelines used to deliver gas from the LDC to the end-user. In order to meet an expected annual consumption of 32 Tcf of gas, it is estimated that interstate pipelines will need to increase by at least 38,000 miles and LDCs will need to add an additional 255,000 miles of intrastate pipeline to keep pace with demand. This expansion will require an investment of roughly $150 billion over the next 10 to 20 years. Likewise, an associated expansion of the LNG infrastructure will be discussed later.

Coal: Coal is the world's most abundant fossil fuel and there is little debate about exhausting our supply of coal in the near future. Conservatively, the world's supply of coal will last another 200 years. Additionally, the US leads the world as the greatest source for all grades of coal.[x] As such, coal is the preferred source of electricity production, providing about 52% of our generation needs.

Trends & Challenges

Although coal provides a ready energy fuel to produce electricity, and many say it is in our nation's best interest to exploit this major resource to the maximum extent possible, in the "green" or environmentally conscious 21st century, coal's nemesis is the carbon dioxide produced during combustion. The clean coal technologies sponsored by the US Department of Energy (DOE) are providing the means to take advantage of our most abundant resource while tackling the carbon problem.[xi] These include the integrated coal gasification-combined cycle demonstrated at the Wabash River Indiana facility, the Weyburn Project in Beluah, ND testing carbon sequestration and the "Future Generation" initiative involving a 275-megawatt electric and hydrogen plant with a goal of 60% efficiency and near zero emissions.[xii]

Nuclear: Nuclear power provides about 20% of our nation's electricity needs. Additionally, its improving capacity ratio (actual electricity generation/maximum possible generation) exceeded 91% in 2002—more than twenty percentage points above its closest industry competitor by fuel type.[xiii] There are currently 103 operational nuclear power plants in the US that provide a clean, stable and secure source of electricity. However, there are significant issues that constrict

industry growth. These include high relative investment costs, waste storage and public perception regarding safety and security.

Trends & Challenges

Although no new plants have been built since 1978, technological improvements have led to increased efficiency of nuclear power plants and resulted in over 2,000 megawatts of power "uprates" in the past 3 years. These capacity improvements along with the increased capacity ratio have resulted in an increase of 154 billion kilowatt hours of electricity produced using nuclear energy between 1993 and 2003, or the equivalent of 19 one-thousand-megawatt nuclear reactors.[xiv]

Of the issues listed, the most prevalent challenge facing the nuclear industry is the storage of its radioactive waste. Although federal legislation mandates a centralized geologic repository for nuclear waste, the US government is overdue in establishing a site that was initially promised by January 1998. Congress recently approved the Yucca Mountain waste repository in Nevada and the DOE is expected to file a license with the Nuclear Regulatory Commission (NRC) this year. The opening date of this site is now projected to occur in 2010.[xv] This delay has caused some resentment by the industry over the unsubsidized additional cost of on-site dry waste storage and is legislatively preventing some states, such as California, from building new reactor plants until the federal repository is fully functional.

There are currently several industry, federal and international initiatives that seem to support growth of the nuclear energy industry. For example, *Nuclear Power 2010* is a joint federal government/industry cost-shared effort to identify sites for new nuclear power plants, develop advanced nuclear plant technologies and demonstrate new regulatory processes leading to a private sector decision by 2005 that orders new power plants for development in the US by 2010.[xvi] Internationally, the Generation IV International Forum, which involves representatives from seven major nuclear power-producing countries, was established to advance a new generation of nuclear power technologies with better economics, safety, reliability and sustainability. This new technology could be deployed by 2030.

Most recently, in an effort to revive the nuclear reactor construction industry, seven major companies, including the two largest nuclear plant owners in the US and two reactor manufacturers, announced that they will apply for a license to build a new commercial power plant. One goal is to test a simplified licensing system created by the NRC that helps the industry go from ordering the reactor to electricity production in just 5 years, as opposed to the 10 or 12 years it took under the previous system. This application may be submitted as early as 2008, and the NRC may rule by 2010.[xvii]

Renewable Energy: Renewable energy sources currently supply 9% of the electrical energy consumed in the US.[xviii] These renewable energy sources include: hydro, wind, solar, biomass, geothermal, and tidal or wave generation. With the exception of biomass, which produces CO2, all other renewable energy sources are considered clean (or green). With their low operating cost and environmentally friendly characteristic, renewable energy sources are very attractive and provide an essential role in reducing our greenhouse gas emissions and reliance on import of fossil fuels. But, in general, they are geographically and somewhat capacity restrictive and each one has its own specific drawbacks.

Trends and Challenges

Although there are relative advantages of renewable sources of energy (indigenous raw materials, relative inexhaustible supplies, generally eco-friendly, etc), they are not a complete

panacea for the fossil fuel problem. Hydroelectric plants, for example, raise concerns about downstream ecosystems and fish spawning impacts and produce electricity only as a tertiary function—behind flood control and water distribution. Additionally, although water is free, it is not always available when you need it, as was the case during California's energy crisis in 2000-2001. As another example, geothermal sites in the US are few and have limited capacity. In addition, aesthetic issues must be addressed if renewable sources like wind and solar energy are to become prevalent in urban environments. Finally, the distributed nature of these sources will place more and more land utilization pressure on policymakers at all levels of government.[xix]

Under current market conditions, renewable sources are not cost effective when compared to coal or gas powered generation facilities. However, the societal and environmental costs of burning fossil fuels is not captured in energy prices. As carbon and other emissions costs become internalized, the cost of these sources will rise. At the same time, renewable technologies are improving and production costs are decreasing. As these conditions converge, renewables will become economically feasible. Some renewable energy enthusiasts contend that if "time-of-day" electricity pricing was widespread, sources like solar and wind are already competitive during peak demand periods. Other policy options to overcome cost-based market barriers include stronger tax incentives for businesses and individuals, federal or state subsidies to fund renewable generation and additional research and development to improve renewable technologies and lower production costs. Collectively, these measures would serve to increase the renewables portion of the nation's energy portfolio.

Transportation

Oil provides approximately 42% of our nation's energy requirements. Two-thirds of this usage falls into the transportation sector. The US is the largest consumer of oil in the world using 19.9 million barrels a day (MMBD). Although an oil producing nation (7.9 MMBD), demand is so great that the US must import over half of its oil needs. Additionally, the demand for oil is projected to increase by 50% by 2025 and US imports will increase to 68% by 2025.[xx] Changes in oil prices directly affect the US economy. Higher oil prices increase the cost of goods and deliveries and reduce discretionary spending by private citizens that in turn reduce the demand for goods and services. Oil, like any commodity, is sensitive to price fluctuations. Its increase in price can be gradual or volatile. Our growing dependence on oil for transportation needs can only be countered by increased efficiency and/or alternate fuel sources in the short term and ultimately through the establishment of a hydrogen (or similar) economy.

Trends and Challenges (Oil, Alternative Fuels, Hydrogen Economy)

Oil: Although predictions vary greatly, most forecasters estimate that the world's oil supply will last for at least another 30 to 50 years. Technology promises to continue to expand oil and gas supplies through advances in exploration and extraction during the near and mid term. Seismic data and computer analysis are reshaping reserve tabulations and current field production. Use of seismic data and computer analysis grew from just 5% in 1989 to 80% by 1996.[xxi] By combining with other new technologies like deeper water and directional drilling, oil companies have begun to explore parts of the world previously deemed unreachable. Even with optimistic estimates, 30% of oil will remain in the ground until new techniques allow extraction of this resource. As prices rise, other grades of oil become economic players. Canada with its oil sands now stands as the second largest oil reserve (174 billion bbl) behind Saudi Arabia (259.3 billion bbl).

Long-term gradual changes in oil prices will occur as oil reserves are consumed. As the world uses the "cheapest to produce" oils of the Middle East, the price of oil will rise. This rise in price will make oil located in hard-to-extract locations attractive to develop. In addition, the demand for oil (and the price) will rise significantly as developing countries such as China and India continue to grow economically and industrially and compete for limited resources. Volatile changes in oil prices are usually due to indirect international issues such as political and diplomatic crises. Currently our main suppliers of oil are Saudi Arabia, Venezuela, and Mexico.

Alternative Fuels: The US has experimented with numerous alternative fuels. Each has benefits but none can immediately eliminate the US demand for foreign imports. Some alternative fuels are used in a gaseous state requiring a complete infrastructure to be developed nationwide before they are 100% effective. Although there are several potential alternative fuels, the discussion below is limited to ethanol and natural gas.

Ethanol is an alcohol distilled from renewable agricultural sources. Most ethanol comes from corn although it can be made from wheat. It is predominantly mixed with gasoline in a 10% ethanol /gal concentration. This concentration allows its immediate use in existing internal combustion engines and, because of the gain in domestic supply and reduction import requirements, provides a 20% reduction in net oil imports used for gasoline. In addition, ethanol burns about 4% cleaner than current gasoline. However, the main problem with ethanol usage is that its production cost is higher than the current price of Middle Eastern oil.[xxii]

Automobiles can also operate under the power of natural gas. Currently only a small percentage of automobiles in the US operate with this fuel source. Although cleaner than oil-based fuels, the major concern with an increased use of natural gas is that it will cause the US to substitute its dependence on foreign oil with a new dependence on foreign natural gas.

Hydrogen Economy: The White House and DOE have developed a future strategy to transition the US from an oil-based to a hydrogen-based transportation system by 2030.[xxiii] To ensure that this challenge is met, DOE's plan includes a $1.2 billion initiative over the next 5 years to accelerate the pace of research and development of hydrogen production, distribution infrastructure and fuel cell technology. In this context, the hydrogen economy is focused more on the transport sector than the broader electrical generation market. Hydrogen fuel cell automobiles provide the most environmentally sound concept for national independence from foreign oil. In its most basic concept, the hydrogen fuel cell uses a membrane to extract electrons from hydrogen atoms (produced by one of several processes) and uses the electric current to power an electric motor that drives the automobile.[xxiv] Not unlike our current gasoline storage in today's automobiles, hydrogen must be stored in sufficient quantity onboard vehicles to allow adequate range. Storing methods for this hydrogen and addressing public conception of the safety aspect of storing hydrogen are just some of the many challenges currently being addressed.

Possibly the biggest challenge is creation of a sufficient infrastructure to generate and distribute hydrogen. Most large-scale oil/gas companies are investing, although minimally, in the development of this infrastructure and at least one small venture capital company has developed a patented method to accomplish hydrogen production using semi-portable small output equipment. As could be expected, development of this infrastructure, without a current demand for it, follows the chicken and egg conundrum that is addressed in the industry challenges section of this paper.

OUTLOOK

The prevailing wisdom suggests that additional electricity capacity is necessary for economic growth in both the short and long term. Providing this capacity will be a vexing problem, unlikely to be solved within the next 5 years. The US has an abundance of coal and a growing natural gas infrastructure, enabling the fuels of choice for large-scale plants. The current grid structure favors high-volume generation plants and requisite transmission and distribution upgrades. However, the Not-In-My-Back-Yard (NIMBY) sentiment is a powerful opposition, regardless of the fuel source. Rising natural gas costs have tempered enthusiasm for new gas-fired generation plants. Thus, despite the recognized need, few new power plants are slated to come on-line soon. Unless demand is curbed, higher electricity bills will likely become the norm nationwide. In the near term, reducing consumption through energy efficiency, conservation and demand-side management initiatives probably offers the best hope for noticeable impact. In the long term, clean, efficient coal and natural gas plants will likely provide the bulk of the base electricity requirements. However, to address infrastructure constraints, NIMBY challenges and environmental concerns, the mix must begin to include more distributed and renewable sources of power. Nuclear power will be the wild card in the generation architecture. Nuclear can be a cheap, indigenous source of power if the public can be convinced that facilities can be operated and waste can be stored safely.

As global demand continues to outpace oil supplies, $2/gallon (and higher) for gasoline will likely become a fact of life in America. Since domestic oil production increases are not expected in the near term, supply diversity will continue to be critical in stemming price volatility and mitigating availability risk. These factors converge into an ominous combination for many US industries. While gasoline will still be “relatively” inexpensive, many US businesses have been relying on cheaper gasoline and other fuels.

The bright side of this outlook is that a long-term shift in the energy price structure may spawn more desirable consumer and producer behavior. Higher costs are forcing corporate and individual consumers to re-evaluate energy usage in the workplace, at home and on the road. Suppliers will meet demand for greater efficiency as long as consumers are willing to pay a higher price. Hybrid-electric vehicles represent a good example for the energy industry. If gasoline prices continue to edge upward and the price gap between hybrids and conventional engines closes, hybrid vehicles could become the rule rather than the exception on America’s roadways by 2020.

Unfortunately, dependence on oil and natural gas imports will continue to grow. Thus, since most of the proven oil reserves are in the Middle East and large natural gas reserves are in Russia and the former Soviet states, stability in these regions will be a critical concern. To complicate matters, demands from high-growth, high-volume economies like China and India will compete with America for energy supplies. Diplomatically, much of the US future influence will depend on how much others perceive the war in Iraq as a war for control over their oil and the outcome and consequences of the conflict.

As a net importer of oil and a growing importer of natural gas, America has not been in a pre-eminent position in energy supply. However, as the world’s largest consumer and as a nation willing to go to great lengths to protect its access to and availability of energy resources, the US energy industry is fairly well positioned to support national security requirements. This said, there are infrastructure concerns related to achieving full surge and mobilization potential. Shipping disruptions, pipeline vulnerabilities and refining capacity are some of the issues that

must continue to be evaluated and addressed to support anticipated national security mobilization needs.

BROAD INDUSTRY CHALLENGES

Establishing a Hydrogen Economy

In his 2003 State of the Union address, President Bush spoke of the need for the US to lessen its dependence on foreign energy sources and to move toward a hydrogen economy—an economy fueled by powerful, portable and pollution free energy.[xxv] Under the hydrogen fuel initiative, more than a billion dollars in federal research and development funding will be invested over the next 5 years in the development of "commercially viable hydrogen-powered fuel cells" and "the technologies and infrastructure to produce, store and distribute hydrogen for use in fuel cell vehicles."[xxvi] The initiative is correct in pursuing both sides of the transition equation, namely the technology that will use the fuel as well as the infrastructure that will provide it. However, by focusing on fuel cell technology—likely the proper end goal for an automotive power source—the current plan fails to address technologies that can support the transition to a hydrogen economy and thus the "chicken and egg" conundrum inherent in the move to a new energy source: How will a new power source become commercially viable absent an infrastructure to support it? How will the necessary infrastructure become commercially viable absent widespread use of its product?

One answer to resolving the fundamental challenge of the hydrogen initiative—the transition from petroleum to hydrogen—could be promoting the development of dual-fuel internal combustion engines that operate on either gasoline or hydrogen. This technology, in contrast to fuel cells, is viable in the near term as demonstrated by BMW's dual-fuel 745H, expected to be commercially available between 2008 and 2010.[xxvii] This approach sends the message that the transition to the hydrogen economy is beginning. It encourages venture capital to move into hydrogen generation, storage and distribution technologies as well as hydrogen power sources currently more mature than fuel cells. As dual-fuel vehicles become more common, market forces will drive the production of the hydrogen infrastructure, encouraged as necessary by government incentives to make hydrogen economically competitive.

Electricity Deregulation

During the growth of the electricity sector in the early 20th century, electric power utilities were vertically integrated (i.e., generation, transmission and distribution belonged to the same company). Because of the natural monopolistic characteristic of these regional utilities and the inelastic nature of the sector's demand curve, the government had been justified in regulating prices to cap the potential excessive profits afforded to utilities and to ensure the benefits of efficiencies are translated to the consumers. In recent years, at least 23 states have implemented some kind of electricity deregulation or restructuring of their markets. Deregulation and the associated legislatively directed divestiture of vertically integrated functions was intended to bring consumers cheaper electricity by creating competition among power providers, thus giving consumers more choices. However, the consequences have not been consistent and have resulted in higher or widely fluctuating prices in some markets.

As demonstrated in California, a competitive market structure will not work unless properly structured. When California deregulated in 1996, their design was flawed in two fundamental ways.[xxviii] First, while the wholesale price that power producers charged utilities was

deregulated, the retail price utilities could pass on to consumers was still regulated or fixed by the state.[xxix] As demand increased, power generation companies increased wholesale prices but the market force that would typically drive down demand was stifled by the inability of distributors to increase retail prices. As a result, utilities were forced to make up the difference. Second, utilities were not allowed to buy electricity from providers on a long-term basis, instead relying on short-term, volatile markets that dramatically drove up prices.[xxx] A current challenge for electricity deregulation is the inconsistency among the deregulated states and the fact that many states have not deregulated at all. Government must ensure a competitive market model is established.

Establishment of Liquefied Natural Gas (LNG) Terminals

Growing US demand for natural gas, coupled with the maturing of domestic gas reserves, has generated high interest in increasing imports of natural gas through more efficient means—the most prominent of which is through the LNG process. By subjecting natural gas to extremely high pressures and low temperatures, it can be liquefied and made more compact. As a result, specially designed ocean-going tankers can then transport LNG over large distances to processing plants that re-gasify LNG for further transport within the US via pipelines.

While overall US imports of natural gas was down approximately 3% in 2003, the LNG portion of total gas imports was actually up by 108% at 144 billion cubic feet (Bcf).[xxxi] These shipments were processed at the nation's four LNG processing plants located in Lake Charles, LA; Elba Island, SC; Cove Point, MD and Everett, MA. While the world's true reserves of natural gas are being refined daily, many experts agree that at current known reserve levels, the US may only have as many as 8 years domestic supply remaining.[xxxii] However, foreign sources imported through the nation's LNG processing plants could extend the service life of natural gas for the US by as many as 200 additional years at current consumption.[xxxiii]

It is estimated that LNG imports to the US from the Bahamas and Baja alone will reach as high as 10 Bcf in 2010, up from almost 2 Bcf in 2003.[xxxiv] However, the processing capacity of the nation's four LNG plants will be exceeded by as early as 2006, necessitating the building of more LNG plants.[xxxv] To address this eventuality, officials have proposed building as many as 31 new plants with two new plants approved for actual construction.[xxxvi] However, it is unlikely that these plants will ever be built, largely due to public safety concerns. LNG conversion is indeed a dangerous process, as liquefying any gas requires extremely high pressures. As such, a handling accident at an LNG plant, although unlikely, could have disastrous effects especially if located in a densely populated area.

Additional concerns about the vulnerability of LNG plants range from terrorist attacks to acts of nature. Proposed offshore LNG processing plants would address some of these concerns, but not all.[xxxvii] Additionally, the training and monitoring programs of the nuclear power industry could be modeled for use in the LNG industry to ensure that only the most skilled personnel operate LNG plants to alleviate most safety concerns. Although the costs of small-scale terminals has been reportedly reduced by 30%, it is estimated that a "standard" LNG terminal might cost in excess of $1.6 billion due to the expense of both storage tanks and harbor facilities.[xxxviii]

Industry's Reaction to the September 11th Attack.

As with most sectors, the energy industry needed to react quickly to the increased risk of terrorist acts. The physical security of most facilities visited has been improved. Changes

included limiting access points and establishing stand-offs to protect against vehicle bombs. On the government side, partly to address the issues raised by 9/11 and homeland security concerns and partly to address the concerns raised by the 14 August 2003 power failures, substantial changes were made to the organization of the DOE, including the creation of the Office of Electric Transmission and Distribution in August 2003.[xxxix]

In summary, the impact of 9/11 on energy security execution was substantial. Among the most important aspects is the increased attention given to industry-wide security issues beyond just nuclear power plant concerns; much greater appreciation for our reliance on electrical power and the vulnerability of the power transmission grid; and an arguably more realistic appraisal of the public policy challenges involved in major changes to energy consumption and usage in the US.

GOVERNMENT ROLE AND POLICY RECOMMENDATIONS

Government must play a significant role in the energy industry by developing policies that ensure energy security, support economic growth and protect the environment. The current administration has attempted to fulfill its responsibilities in the policy arena by forming the National Energy Policy Development (NEPD) Group. Chartered in early 2001, the NEPD was tasked to develop a national energy policy designed to help the private sector and, as necessary, state and local governments to promote dependable, affordable and environmentally sound production and distribution of energy for the future.[xl] The NEPD outlined numerous US energy challenges similar to those we face in the US and address in this study.

Among the many NEPD recommendations, the Group proposed that the President instruct executive agencies to work closely with Congress to implement the legislative components of a national energy policy, highlighting the obvious and inextricable link between energy policy in the Executive Branch and the legislative process on Capitol Hill.[xli] To date, Congress has not passed any energy legislation addressing the energy challenges. In fact, an omnibus energy bill entitled *The Energy Policy Act of 2003* (HR6) is stalled on Capitol Hill. Three years after the issuance of the NEPD report, the US has little to show for its efforts. With this in mind, the following recommendations are offered to improve the policy and legislative process:

- The various stakeholders need to organize themselves openly along non-partisan lines to develop a logical framework for addressing a manageable and prioritized number of energy policy and legislative actions.
- If such a non-partisan framework can gain support in the White House and on Capitol Hill, policymakers should examine ways to approach low-hanging fruit projects instead of concentrating on numerous wide-ranging initiatives.
- The White House and Congress must be willing to make some tough political choices that result in alternative forms of automobile transportation (e.g., hybrid vehicles, natural gas, hydrogen, etc) becoming more attractive than vehicles powered by gasoline internal combustion engines.
- The rapidly increasing demand for energy in Asia, the conflict in the Middle East and the instability in Venezuela will continue to negatively impact worldwide energy supply and prices. As such, the energy security strategy needs to include an international focus that supports our interests in these sensitive parts of the world.

To expand on more specific energy policy and legislative actions, government attention is required in three key areas: the hydrogen economy, electricity deregulation and the liquid natural gas sector. Accordingly, we offer the following policy recommendations:

- **Hydrogen:**
  - The US DOE, in coordination with the US Department of Transportation, should continue research and development activities supporting hydrogen fuel cell and infrastructure development.
  - DOE R&D resources should be reallocated to ensure emphasis is placed on technologies that enable petroleum-to-hydrogen infrastructure transition.
  - Tax incentives or subsidies at the federal level should be considered to encourage the development and production of dual-fuel engine technologies and the sale of dual-fuel vehicles with the goal of accelerating the commercial availability and widespread use of dual fuel fleet and passenger vehicles.

- **Electricity Deregulation:**
  - The Federal Government must take the lead in establishing basic guidelines for the deregulation of both the generation and retail sale of electricity in order to maximize the competitive market model and ensure uniformity among states or regions.
  - To create additional generation capacity, government must look at providing subsidies or tax incentives to make the creation of more generation plants feasible. These incentives should be structured to ensure we develop a diverse generation portfolio that includes nuclear power as well as added emphasis on renewables.
  - The Federal Energy Regulatory Commission (FERC), which regulates wholesale interstate electricity commerce, should be given the authority to police markets for price gouging. As an interim step towards full deregulation, FERC's powers should be expanded to include oversight of generation, grid access, cost of transmission usage and retail market prices. This interim step should be required until consumers have the knowledge and ability to easily choose between suppliers and distributors.
  - Government should enact legislation clarifying state and federal jurisdiction over the electricity grid, and steps must be taken to strengthen and expand the current grid that was not designed to support transmission over long distances.
  - Government must take the lead in fostering demand-responsive technology so the forces of supply and demand can function effectively. In other competitive markets, consumers know the price they will pay beforehand and are able to change their consumption in response to price changes.

- **LNG:**
  - Conduct a national public relations campaign to educate the general public to the actual risk LNG imposes.
  - Streamline the LNG processing facility permit and approval process to expedite the building of new plants.
  - Provide incentives to industry to incrementally increase the building of additional LNG terminals commensurate with a simultaneous increase in natural gas pipeline expansion.
  - Assist in R&D in off-shore LNG terminals and underwater flexible pipeline systems.
  - Assist in R&D of improved technology that can locate and identify natural gas reserves with minimal impact on the environment to enable the potential extraction of gas from previously protected areas such as wildlife reserves.

ESSAYS ON MAJOR ISSUES

Energy and the Environment

Debates over the 'proper' balance between preserving the environment and meeting US energy requirements are nothing new. For decades, environmentalists have fought to minimize the impact of raw material extraction and energy production while industrialists have sought more and cheaper fuel sources. It has become the classic battle of good versus bad…"Mother Earth" versus the "bottom-line." The US—and global—economies ebb and flow with energy prices and availability and thus the battles over environment and energy industries are no small matter. Movements in energy availability and price affect the entire nation.

The environmental impact of harvesting and transporting raw materials for energy production is substantial. The exploration for crude and petroleum production have detrimental impacts on soils, surface and ground waters and the ecosystems. Improper disposal of produced water (the saline water extracted with oil and gas), accidental hydrocarbon releases and improperly sealed abandoned oil wells are major contributors to environmental damages. Beyond the obvious damage to the environment, the long- and short-term effects of these damages need to be understood by local communities when converting old or depleted petroleum and gas fields to residential, agricultural or recreational areas.[xlii]

Environmentalists are apprehensive about the long-term impact energy resourcing will have on the planet and call for a reduction of fossil fuel use through conservation and alternative fuels research. Damage to the environment from fossil fuel extraction infrastructure—roads, pipelines, pumping stations, etc.—is a major concern. Environmentalists are also concerned with the transportation systems (boats and pipelines) used to move petroleum products strategically. Approximately 15% of the world's 1,800 oil tankers were built before 1980 in Japanese shipyards using inferior steel. More than 60% of these ships are single-hull design, and increasing the probability of spills. Single-hull ships are scheduled for retirement in 2015 but many are nervous about the potential global damage between now and then. Without regulatory intervention, it is unlikely that maritime petroleum transportation will improve.[xliii]

From the industrialist's point of view, the environment is secondary. That's not to say that commercial industry is totally callous toward the environment, but the reality is that its emphasis is on the bottom-line. Their shareholders expect return on investment and that means finding ways to increase revenue. Increased revenue typically comes from production efficiency or less expensive raw materials. Controversies over drilling on public lands have become more heated as the Middle East becomes increasingly unstable and crude prices rise. Today, public lands provide 30 to 35% of America's daily energy and the energy industry wants more access to the protected properties. The US government cannot and will not, restrict oil and gas development on all public lands as it would have a major impact on our economy. Finding the 'proper' balance between energy resourcing and the environment is a continuous battle.[xliv] In this election year, the economic reality appears to be that the US priority is cheaper and internally sourced energy without significant concern for the environment. President Bush's attempt to open the Arctic National Wildlife Refuge to oil exploration emphasizes this point and raises serious questions from environmentalists about the future direction of America's energy policies.

After 25 years on the 'blacklist' of America's energy sources, coal is making a strong comeback as an affordable source of electricity.[xlv] Continuing concerns over dependence on and

the cost of Middle East oil are shifting US energy industry interests toward coal as the dominant fuel of the future. Coal is the largest source of available energy in the United States. Coal accounts for almost 35% of domestically produced energy and 23% of all energy used. It is the basis for 50% of all generated electricity and contributes over $150 billion to the US economy annually[xlvi]. Believed by many to be a "dirty industry," the commercial coal companies are putting significant effort into changing public opinion in terms of land damage and air pollution. While generally supporting requirements to modernize infrastructure to reduce pollution, the coal industry continues to look for a balance between regulatory requirements and the bottom-line. Promising energy to meet America's insatiable appetite at costs below petroleum prices, coal seems the answer to energy supply problems in the future. Environmentalists are not so sure.

Of significant note to environmentalists is coal's reputation as a "dirty fuel." Quite simply, burning fossil fuels puts carbon dioxide (CO2) into the atmosphere. Increased levels of CO2 prevent heat from leaving the atmosphere, resulting in global warming. "Global warming means more air pollution and problems with water supplies as precipitation patterns change, as well as huge threats to ecosystems from the Everglades to the glaciers. Forests, farms and cities will face troublesome new pests and more mosquito-borne diseases. Scientists say many of these symptoms are already appearing."[xlvii] Existing coal industry infrastructure is old and, in many cases, has not been upgraded to meet Clean Air Regulatory requirements. While considerable strides have reduced surface and ecological damage of strip or underground mining, much remains to be done to reclaim and clean previously damaged environments.

Environmentalists point with concern to the expanding coal infrastructure—94 new plants proposed in 36 states—and the potential impact on global warming. According to the National Energy Technology Laboratory (NETL), these new plants could add 62 gigawatts, or another 20% to current US coal-generating capacity. While this infrastructure expansion will provide additional inexpensive energy, the question on environmentalists' minds is at what long-term cost. The US is already the leading contributor to global warming. With only 4% of the world's population, we produce 25% of the carbon dioxide pollution. According to NETL, if even half of the proposed plants were actually built, it would add 120 million cubic feet of exhaust gases every minute of every day…to what is currently vented.[xlviii] Clearly, coal is abundant and cost-effective, but there are some challenges to overcome.

To address these issues, government must take the lead and develop a well-planned energy strategy. However, no single federal agency has strategic responsibility for US energy policy. The Department of Energy (DOE), Environmental Protection Agency (EPA), Department of the Interior (DOI), Nuclear Regulatory Commission (NRC) and the Department of Transportation (DOT) all play a role in establishing energy policy and monitoring standards. The various federal agencies take multiple courses of action without adequate direction or attention to the real issue—a comprehensive and integrated national energy policy. Without a single agency or office with end-to-end responsibility for energy strategy, the US is unlikely to develop or employ a successful energy policy.

The DOE, while the logical choice as the focal point for US energy strategy, has surprisingly little to do with energy policy. In fact, DOE's defined role is:

- Protect our national security by applying advanced science and nuclear technology to the Nation's defense.
- Protect our national and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy.

- Protect our national and economic security by providing world-class scientific research capacity and advancing scientific knowledge.
- Protect the environment by providing a responsible resolution to the environmental legacy of the Cold War and by providing for the permanent disposal of the Nation's high-level radioactive waste[xlix].

In terms of their role, the DOE Strategic Plan states only that the "principle tool in national energy policy is science and technology [and by] working with private industry, DOE is developing new exploration, development and productions processes that will keep US oil fields producing well into the future."[l] While this might advance our production capabilities, it has nothing to do with policy development. In fact, nowhere in the DOE Strategic Plan is development of an energy strategy addressed. Instead, most of DOE's resources are committed to energy research and development and waste clean up.

The NRC is responsible for all matters related to nuclear regulation, inspection, licensing and standardization. The NRC's mission is "to ensure adequate protection of public health and safety, promote the common defense and security, and protect the environment by regulating the Nation's civilian uses of nuclear fuels and materials."[li] To meet their mission requirements, the NRC monitors nuclear power plants, non-power reactors, nuclear fuel cycle facilities, waste disposal and the industrial and medical uses of nuclear materials. The NRC focus is on nuclear safety, not electricity generation.

The DOT and EPA establish policy related to vehicle fuel efficiency. Enacted by Congress in 1975 in response to the 1973-74 Arab oil embargo, the Energy Policy and Conservation Act established the Corporate Average Fuel Efficiency (CAFE) manufacturing standards for cars and light trucks. CAFE sought to reduce fuel consumption by increasing vehicle fuel efficiency.[lii] Together DOT, through the National Highway Traffic Safety Administration, and the EPA regulate CAFE standards. Here again we have federal agencies working their energy policy niche without apparent regard to a strategic energy picture.

The Department of the Interior Minerals Management Service (MMS) administers programs to effectively manage mineral resources located on the nation's outer continental shelf. These programs include environmentally safe exploration, development and production of oil, natural gas and the collection and distribution of revenues for minerals developed on Federal and Indian lands.[liii] MMS has oversight of about 7,300 active leases on 42 million acres and is responsible for transfer of oil from offshore leases to the Strategic Petroleum Reserve. With over 280 million onshore acres and 1.76 billion offshore acres of land with unknown quantities of oil and gas, MMS sees their programs as viable solutions for the nation's future energy requirements. Currently DOI managed public-lands (on-and off-shore), provide about one-third of all domestic coal, oil and natural gas.[liv] The Gulf of Mexico produced about 1.7 million barrels a day in 2002 and DOI hopes to increase those numbers significantly through deepwater projects in 2004-2006. MMS works with state and local coastal governments to protect coastal and marine environments while managing a domestic energy source for the American people. Again, MMS has the potential to make a major impact on US energy policy but is working toward their own goal (versus a strategic US goal) to satisfy America's energy requirements.

Recommendations: To remain competitive in the global market, the US must continue to fuel industrial growth. To do this, the US must take the steps necessary to align environmental and energy policy. This policy should reduce dependence on imported fossil fuels and expand US exploration while preserving the ecosystem. Currently, the departments responsible for energy

policy seemingly work against each other instead of working together toward common goals. To this end, the following recommendations are made:

- First, identify a single federal agency as the focal point for US energy policy. This office is responsible for integrating all efforts and programs associated with national strategic energy policy. The DOE is the appropriate agency for this role. However, to meet this role, DOE would need restructuring. The current structure—organized by sources of fuel with each developing independent energy strategies—is inefficient. A more efficient structure would place all energy sources under a single division to gain a comprehensive perspective on energy policies.[lv] Additionally, all energy policy responsibilities from other federal agencies should transfer to DOE. This will place responsibility for all energy standards and management under one roof.
- Second, there must be some incentives for industry to "clean up its act." The efforts of the Clean Air Act and other "anti-pollution legislation" are commendable but lack the political power or financial incentive (or penalty) to motivate commercial industry to invest in needed energy and environment modernization. Tax incentives and shortened amortization payoffs on infrastructure capital investments could prompt industry upgrades to aging, inefficient and polluting plants.
- Finally, industry and government must work together to develop competitive and affordable alternative energy sources. The global fossil fuel resources will eventually be gone. We should invest time and money in research to develop viable alternative energy sources. We cannot afford to wait until natural resources reach critical limits. For the economical and physical security of our nation, we must begin now.

Summary: The fact that no single person or agency is currently responsible for developing a comprehensive energy policy makes it highly unlikely that the US will develop a viable energy policy in the near term. Additionally, the efforts by the five primary federal agencies responsible for energy policy do not build on each other; instead, they are myopically focused and are not strategically integrated. Any strategic decisions about future energy policy require additional research on the environmental impact of fossil fuels and global warming. An actionable national energy policy will require cooperation and coordination between industry, government and the public. A strategic energy policy will have to address not only the complex interrelationships between energy and the environment, but force the development of affordable, safe energy alternatives.

- Lieutenant Colonel Linda Dahl, USAF

International Perspective:

The Energy Industry Study visited Norway, Iceland and Ireland. Though significantly varied in their domestic energy resources and national energy policies, all are extremely sensitive to the interrelationship of energy, the environment and the economy. Each is a committed signatory to the Kyoto Protocol and has attempted to adapt its energy policies toward that end. Hand-in-hand with these national environmental concerns is the fact that none of these countries currently will consider domestic nuclear energy usage. Although each recognizes the importance of its energy sector to the advancement of the economy, Norway and Iceland, blessed with fairly significant domestic energy resources, have put together viable energy plans to meet current and future demand. To the contrary, Ireland, with limited energy resources and hindered by its island

status, is struggling much like many other industrialized nations to solidify a future-oriented energy program.

Norway: From an energy resource perspective, Norway is enormously wealthy, yet its culture has shaped policies that might suggest exactly the opposite. Hydro-electric power supplies nearly all of Norway's electricity needs throughout the year. Oil discoveries along the Norwegian coastline have brought more oil than Norway can possibly consume making Norway the world's third largest oil exporter. Offshore natural gas fields also make Norway an important player in future natural gas markets. Despite this abundance, electricity rates are high and rising, and gasoline prices in Norway remain the highest throughout Europe. In America, these conditions would be cause for revolt. However, for Norwegians, this situation is not only palatable but apparently preferable. Insights into why Norwegians think as they do might be useful in shaping future US energy policies.

Norway is often cited as the best model for oil-rich nations. However, the reasons for Norway's success are varied and may not be repeatable in other regions of the world. For starters, long before oil was discovered at Ekofisk in the North Sea, Norway had strengths in other industries (principally fishing), other energy resources (hydro-electric power) and an already established, stable and mature democracy. In addition, Norway has benefited from a relatively small population with regard to energy consumption. Norway is therefore in an enviable position where supply easily exceeds demand. Based on these market forces, prices for electricity and gasoline would be expected to be very low. However, the Norwegian culture and societal and political framework stresses environmental concern, long-term self-sufficiency and egalitarianism. As a result, Norway has taken a more strategic perspective on its oil riches and established a Petroleum Fund that will serve as a security blanket for the nation when its oil and natural gas supplies are exhausted. However, Norway has succeeded with its fund by instituting policies and procedures that prevent "dipping" into this fund to cover budget shortfalls. Time will tell if other nations are as successful with this "trust fund" model.

The relative stability in its electricity production and infrastructure has also enabled Norway to take the lead in the Nordic power exchange market. Nord Pool, the world's first multinational power exchange, is characterized by a competitive, transparent wholesale market and a flexible, open retail market. Thus, participants in the wholesale market can trade at spot prices in the futures and forwards market for price hedging or enter long-term contracts for price stability. On the retail side, large-scale (businesses) and small-scale (homeowner) users are empowered with the ability to select among available suppliers and various contract types. This structure is a model worth examining for applicability in US markets.

While Norway has avoided the "Dutch disease" often linked with oil wealth, it is not completely immune to some of its effects. Innovation and entrepreneurship are keys to Norwegian success in maximizing oil revenues; however, ironically, they have not translated well into other industries. It has been difficult for Norway to compete with Finland and Sweden, which have fewer energy resources, but have taken the lead in high technology sectors such as telecommunications. Aside from the fishing industry, few new industries have risen to prominence. Arguably, Norway is not maximizing the full economic potential of its highly educated public. The escalating tax structure dissuades workers from considering overtime to increase productivity. Absenteeism is also a growing concern. Many of these issues are symptomatic of a social welfare state.

Iceland: Iceland, an island country of 288,000 people, is located along the Mid-Atlantic ridge in the North Atlantic. Though geographically isolated, its indigenous "green energy" and aggressive research into alternative fuels have prompted the current government to issue a stated goal of future Icelandic energy consumption based on renewable energy sources with a move toward self-sustainment.[lvi]

The energy resource base in Iceland is significant, with domestic renewable power in the form of geothermal energy contributing more than 50% of primary energy consumption, primarily for space heating and electricity generation. Geothermal along with hydropower produces over 72% of the total energy consumed in the country. Iceland enjoys a plentiful supply of these and other renewable energy sources. Its electricity generation is entirely derived domestically and has the capacity to provide electricity for approximately 6 million people. Rounding out energy usage within the country, Iceland imports fossil fuels that account for approximately 25% of primary energy use, mainly to fuel their fishing and transportation sectors.[lvii]

Iceland's greatest weakness centers on its reliance on foreign sources for necessary petroleum fuels to meet transportation and marine requirements. This dependence, in a country that prides itself on independence and high levels of technological education, has driven Iceland to the forefront of alternative fuels research and development. Another potential weakness is that its energy grid is completely isolated with no ability for reinforcement from outside sources, but this is minimal given that both the geothermal and hydropower capacities are well managed and not affected by short-term climatic conditions.

Iceland's opportunities are many, especially if export of its energy surplus should become feasible. A submarine cable to either the European continent or the United Kingdom would aid in meeting the growing demand for green energy in Europe and would additionally provide reinforcement for the Icelandic electricity grid.[lviii] Although not currently economical, new technologies and increasingly greater power requirements may change that feasibility in the next several decades. Until then, with its continued overabundance of energy, Iceland is seeking to bring power intensive industries to its shores, providing continued stimulus to its economy through the sale of highly competitive electricity, but always with a watchful eye toward environmental and cultural impact.[lix]

Internationally, Iceland's commitment to the Kyoto Protocol with a required reduction in greenhouse gas emissions as well as their desire for a more secure energy supply has driven them to take a leadership role in exploration of hydrogen as an energy carrier, particularly in the form of fuel cells. Though not yet cost-effective for public utilization, Iceland is operating and testing the world's first hydrogen fueling facility and three hydrogen-fueled public buses. Iceland is committed to, and a world leader in, research in support of a future hydrogen economy.[lx]

Iceland is unique; it has vast domestic energy resources from which to draw while supporting a very limited population in a country similar in size geographically to the state of Virginia. Yet this small nation offers the US and other nations a lesson in both domestic and international leadership. Through an established and well-communicated energy policy, Iceland has committed itself and its people to further utilizing its natural resources and continuing as a world leader in hydrogen research, with an aim at reducing or fully eliminating its dependence on foreign energy. With the assistance of other industrialized countries, Iceland will continue to work to solve its and the world's problems of present and future energy demand.

Ireland: As recent as the late 1920s, the vast majority of the Irish population did not have access to electricity, but beginning in 1927, the government began an aggressive campaign to electrify the entire country. Similarly, there has not been a historic large demand for automobiles in the country. With a relatively small population and economic base, the growth in demand for energy to service the electricity and transportation sectors was not a major problem, but that situation has now changed. With a population of nearly four million people and growing at a rate of over 1% annually, Ireland is now facing the need to balance its rapid economic growth of the 1990s and early 2000s against its current desire for energy security and environmental protection.

Ireland is a huge net importer of energy, with 84% of the country's total energy requirement coming from external sources in 2000.[lxi] Energy consumption averages around 55% from oil, 23% from natural gas, 14% from coal, 5% from peat and 3% from renewables.[lxii] The only indigenous energy resources are limited amounts of natural gas and peat, necessitating the country to import nearly 3.4 billion cubic meters of natural gas each year.[lxiii] Energy consumption in 2000 amounted to 29% by the transportation sector, 24% by the industrial sector, 23% by the residential sector, and a combined 24% by other sectors (e.g., commercial, public service and agriculture).[lxiv] The latter three, amounting to 71% of total energy consumption, roughly comprise the electricity market in Ireland.

In trying to strike the best balance between economic growth, energy security and environmental protection, Ireland is developing a national energy policy to address challenges stemming from four main themes: energy infrastructure, energy sustainability, compliance with Kyoto emission requirements and market/regulatory structure.[lxv]

While the "Celtic Tiger" economy enjoyed impressive levels of growth during the last 14 years, improvements in Ireland's energy infrastructure have not kept pace with the economic boom. As such, Ireland is facing a need for increased investment in electricity generation, electricity transmission and natural gas networks. Although a member of the EU, geography (it is an island off an island off the Continent) has made it difficult to integrate its power grid with that of Europe; thus, Ireland faces a particular challenge in meeting the European Union's mandate for a single, integrated electricity market. Nevertheless, expanding connections to Great Britain (the Irish government is considering two 500KV direct current connections) and continuation of planned internal improvements will certainly help. Ireland is also looking at ways to improve the reliability of the system in order to facilitate a large megawatt load of wind-generated electricity hooking into the grid.

With 84% of its energy resources coming from imports, Ireland is seeking ways to improve energy sustainability. To accomplish this goal, the country believes that a continuation in the use of coal (albeit imported) and indigenous peat, along with the increasing use of natural gas (from both indigenous and, increasingly, imported resources) is the best way to accomplish this goal. The reliance on peat-powered electrical generation is of particular interest since it is a carbon-intensive and relatively expensive form of electricity generation. Nevertheless, this energy source continues as a way of maintaining a small amount of indigenous energy security and of subsidizing the Irish peat industry. There are currently no nuclear electricity plants in Ireland and this energy resource has been ruled out.

Ireland is very aware that expanding its energy infrastructure must be closely linked to environmental protection. Nevertheless, a particular challenge for the country involves coming to grips with the EU's commitment to meeting the Kyoto protocol emission targets. Of specific concern is the fact that Ireland's target within the EU allocation is 13% above 1990 levels, but

based on current forecasts, emissions will grow in excess of 25%. Additionally, due to budget considerations, it has chosen not to get involved in research toward a hydrogen economy. As such, Ireland faces a huge challenge if it is to show "demonstrable progress" by 2005, as required by Kyoto. On a positive note, Ireland is opening its energy markets (as required by the EU) and is rapidly moving away from the previous electricity monopoly enjoyed by the Electricity Supply Board and its electricity interconnection with Northern Ireland has led to consideration of an all-Irish grid on a non-political basis.

In summary, Norway, blessed with oil and natural gas, appears to have put in place a system, the Government Petroleum Fund, that might keep it from squandering either the resources or the profits involved in exploiting those resources, investing much of the profit to be used for future needs when their oil resource might be exhausted. Iceland, a country with an environmental conscience and already significant utilization of clean energy, still insists on doing better, thrusting itself to the forefront of hydrogen research in the hopes of one day becoming independent of imported fossil fuels. The island country of Ireland has come to recognize its limited indigenous energy resources and thus the inability to ever be energy self-sufficient; hence it has made the effort to improve its natural gas and electricity interconnectivity with the United Kingdom. Although the above mentioned countries are significantly smaller than the United States in both land mass and population, each offers great examples of integration of energy issues and solutions within their grand strategy.

- Mr. Manish Patel, USA; Colonel Louise Terrell, USA; Captain Dave Hill, USCG

Surge and Mobilization Requirements

Why should military officers attending the Industrial College of the Armed Forces study specific industries like energy? Because in the twentieth century, the ability to mobilize national industrial or economic power was crucial to national defense. During WWII, US defense spending as a percentage of GDP increased 41.4%. It is doubtful that the US energy industry could support such growth today, since it has little or no excess capacity. However, there is also little need for such growth to support anticipated defense requirements. The US economy has continued to grow, and today's wars no longer require massive commitments of manpower and resources such the first and second world wars. Defense spending as a percentage of GDP for the Korean War increased by 8%; for the Vietnam War, by 1.9%; and for the first Persian Gulf War by only 0.3%[lxvi] Defense spending for the Bush defense buildup and the Global War on Terrorism as a percentage of our $11 trillion economy increased by about 1%.[lxvii] So, it would appear that normal peacetime economic growth creates greater demands for energy than recent or current war requirements.

Nevertheless, the US can no longer meet its internal demand for fuel from domestic sources. In 2002, the US imported about 58% of the oil it consumed.[lxviii] The critical defense question in the energy sector relates to fuel. The question is not whether the US domestic petroleum industry can support DOD's fuel requirements. It does not now; fuel for overseas DOD units is purchased overseas. The question is, can the global petroleum market support DOD fuel requirements?

Change in War Requirements: It's not just that the size of the US economy has grown so large; it's also that how we fight wars has changed. Instead of relying on masses of troops, equipment and supply, we now use far fewer, better trained troops and have replaced quantity of

weapons with quality and precision of weapons and intelligence. Fewer planes, fewer tanks and fewer ships translate into reduced fuel requirements. In addition, the threat has changed. After the collapse of the Soviet Union, the US military downsized to meet two nearly simultaneous Major Theater Wars.

Impact on Defense Fuel Requirements: The change in defense requirements alters the magnitude of US military fuel requirements. For example, in the 1980s during the Cold War with a larger force structure, the US military used on average 180 million barrels of oil a year. After the end of the cold war and the subsequent downsizing of the US military, average peacetime military usage averaged 110 million barrels of fuel a year.[lxix] In FY 2002, increased fuel requirements for the campaign in Afghanistan (Operation ENDURING FREEDOM) and for air patrols over U.S. cities (Operation NOBLE EAGLE) pushed US military fuel usage to 135 million, an increase of 25 million barrels or 23%.[lxx] In FY 2003, military fuel consumption increased to 143 million barrels to support Operation IRAQI FREEDOM.[lxxi] Still that represents only 33 million barrels over peacetime levels. For comparison, fuel consumption for Operation DESERT SHIELD/STORM was 45 million barrels over peacetime levels.[lxxii] To put this in perspective, in 2002, total worldwide production of oil was 74 million barrels per day.[lxxiii] While demand for oil is increasing, so is supply as more reserves are found and developed each year. Demand may push up the price of oil, but the world economy can easily provide the quantities of fuel envisioned for the kinds of conflicts the US military is planning to fight.

Military Specification (MILSPEC) Fuels: This does not mean shortages are no longer a problem. For example, in the current Iraqi campaign, shortages of body armor were widely publicized in the media. A potential problem in the energy arena for the military is its use of military specification (MILSPEC) fuels. This fuel requires special processing and additives. Since it is specially produced for the military, it is not available on the commercial market. So, even in a market awash in oil, DOD could experience shortages. DOD uses three types of MILSPEC fuel:

- JP-5, Navy Aircraft Carrier Jet fuel, high flashpoint (140^{o} F).
- F-76, Navy Marine Diesel fuel
- JP-8, "Single Fuel" used for both ground vehicles (e.g., tanks) and ashore air (jets and helicopters)

In theory, shortages of MILSPEC fuel could ground Air Force planes, and stop tanks in their tracks and confine ships to port. In reality, except for JP-5, there are acceptable commercial alternative fuels.

JP-8 is used by almost all Army, Air Force, Marine and Navy shore aircraft, vehicles and equipment. JP-8 is commercial JET-A1 fuel with three additives: a fuel system icing inhibitor, a corrosion inhibitor and an electrical conductivity additive. Though not a MILSPEC fuel, JET-A1 is the international standard aviation fuel, readily available worldwide except in the US. In the US, JET-A, a variation JET-A1, is used for domestic flights. The only difference between JET-A and JET-A1 is in minimum freeze points: -47^{o}F for JET-A1 and -40^{o}F for JET-A. JET-A1 is frequently used by US ground forces and Air Force jets. The commercial fuel JET A1, not the MILSPEC fuel JP-8, was used as the single fuel on the battlefield during DESERT STORM.[lxxiv] During peacetime, DOD aircraft obtain JET-A1 fuel at commercial airports throughout the world.[lxxv]

F-76, Navy/Marine Diesel fuel, is the primary fuel for Navy ships. It is similar to commercial Marine Gas Oil (MGO). The primary difference between F-76 and MGO is the stability requirement for F-76. F-76 is produced for storage for extended periods as war reserves. As with JET-A1, Navy ships purchase locally (after testing) MGO when F-76 fuel is not available. Since it is a commercial product, MGO is readily available in large quantities in almost every port in the world. Although there are some concerns about quality standardization, MGO has been used by Navy ship without significant problems.[lxxvi]

There is, however, no acceptable commercial substitute for JP-5, Navy jet fuel. Because of the high temperatures on aircraft carriers and because crew cannot easily evacuate or escape a fire, the Navy requires a fuel with a high flash point. Flash point refers to the temperature at which enough of the fuel will evaporate, for the vapor to ignite or flash into flames in the presence of a spark. JP-8 and JET-A1 require a minimum flash point of 100^{o}F, which is not good enough. JP-5 has a flash point of 140^{o}F.[lxxvii]

Fuel War Reserves: Because MILSPEC fuel is not readily available on the commercial market, DOD maintains special war reserve stocks to handle surge requirements. In 1991, DOD stored war reserves stocks of about 60 million barrels, although by 2003, DOD reduced the reserve to about 30 million barrels.[lxxviii]

Operation ENDURING FREEDOM (Afghanistan): The campaign against Al Qaeda and the Taliban in Afghanistan provided a test case for DOD's ability to provide fuel support for military operations. With no established bases in the region, extremely long distances, no direct sea access and poor local infrastructure, it was arguably the most difficult fuel logistics operation imaginable. In the end, DOD solved the problem by using not just MILSPEC fuel, but also Soviet formula jet fuel (TS1) available in the bordering "Stans" Republics (Tajikistan, Turkmenistan, and Kyrgystan, Uzbekistan and Kazakhstan) as well as JET- A1. Instrumental in this was DOD's Additive Program. By adding certain additives, JET-A1 could be turned into a fuel equivalent to JP-8.[lxxix] Underscoring the global nature of the petroleum industry, was the crucial role played by Shell-Pakistan in supplying JET-A1.[lxxx]

Conclusions and Policy Recommendations: Although the nature of the US economy and method of war fighting have changed dramatically since WWII, the fundamental importance of industry for providing the means for war fighting remains. The US military cannot fight without fuel. Although the price of fuel may rise, given the relatively small amounts of fuel needed for the military to fight relative to the world supply, fuel shortages should not be a significant issue for the military in the next several decades as long as the US has access to the global fuel market.

DOD needs to review its MILSPEC fuel policy. Except for JP-5, there appears to be little added benefit to the use of MILSPEC JP-8 and F-76 over the commercial equivalents JET-A1 and MGO. By insisting on MILSPEC fuels, DOD limits its number of potential suppliers and loses the potential cost savings that its large market share should provide. Since DOD philosophy is to train the way it fights, DOD should consider using commercial fuel in peacetime.

DOD should also review its current fuel war reserve levels. Given that it frequently uses commercial fuels when it actually fights, maintaining war reserves of JP-8 and F-76 appears not to make economic sense. DOD should reduce its fuel war reserve levels. Those reserves that are maintained should be largely JP-5.

-Dr. Richard Allen, OMB

CONCLUSION

Ensuring a reliable and secure energy supply is absolutely essential in maintaining both our economic well-being and national security. The use of energy for electricity generation and transportation is the major source of energy consumption in the US. Like other industrialized nations, the US has built its economy primarily around the use of fossil fuels. Since developing nations are so largely dependent on fossil fuels for meeting their energy needs, this worldwide demand poses two fundamental challenges: environmental degradation and continued access to affordable and reliable energy sources in support of economic growth.

With respect to electricity generation, the international pressures associated with reducing green house gas emissions and our position as a major consumer of electricity force us to take a leading role in balancing electricity generation and environmental concerns. The continued role of nuclear power as a base load provider along with increased development of renewable sources is essential in establishing this balance.

As for transportation, hydrogen fuel cells pose the greatest potential as a source of energy to replace our petroleum-based economy. It is environmentally friendly and will free us from most, if not all, of our foreign energy dependence. Although the US has set a national goal of achieving a hydrogen economy by the year 2030, we feel this is likely not to occur until the US develops a comprehensive national energy strategy that includes an achievable hydrogen economy road map.

In addition, the government must continue efforts that promote or mandate increased energy efficiency standards. This could be accomplished by implementing more stringent Corporate Average Fuel Economy requirements and appliance and new construction standards (both industrial and residential). Furthermore, we must curb demand to prolong usage of existing energy resources. Although rising energy costs may be enough to force consumers to conserve, a public awareness campaign is required to educate consumers on available conservation methods.

The May 2001 *National Energy Policy*, albeit a dated document, is a good start but is not the detailed strategy needed to secure our future energy needs as we move into the new century. Changing the infrastructure to support a hydrogen-based economy is going to take strong political leadership and a visionary approach. As it now stands, oil, natural gas and coal will continue to be the dominant sources of fuel for the foreseeable future until the US gets serious about new or alternative sources of energy.

In the meantime, regional instability and the geopolitical realities shaping the world and affecting energy resources will continue to preoccupy our national leaders and impact the functioning of our national and global economies. As China and India continue to emerge as industrial powers, fossil fuel-based energy sources will become even more scarce. Increasingly, the US will be forced to rely on imports and the global market to meet its ever-increasing demand for energy resources. Although the US energy industry is not currently in crisis, the coming years may be difficult if steps are not taken now to wean ourselves from foreign dependence.

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