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GEOGRAPHIC CONCENTRATION OF OIL INFRASTRUCTURE: ISSUES AND OPTIONS

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USAWC STRATEGY RESEARCH PROJECT

GEOGRAPHIC CONCENTRATION OF OIL INFRASTRUCTURE: ISSUES AND OPTIONS

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ABSTRACT

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The nation's energy infrastructure is vulnerable. A key vulnerability is the concentration of oil infrastructure in the Gulf of Mexico. After the security shock of 9/11 and the energy disruptions caused by Hurricanes Katrina and Rita, many analysts questioned this geographic concentration of oil infrastructure and proposed that dispersion might reduce infrastructure vulnerability. This SRP describes the vulnerabilities of geographic concentration of the oil infrastructure through a short case study of the effects of Hurricanes Katrina and Rita. Its assessment of the advantages and disadvantages of geographic dispersion of U.S. oil infrastructure is followed by recommendations for how the industry and the U.S. government can create a less vulnerable infrastructure.

GEOGRAPHIC CONCENTRATION OF OIL INFRASTRUCTURE: ISSUES AND OPTIONS

Since the discovery of oil reserves in the Middle East, industrialized nations, the United States in particular, have become increasingly dependent upon foreign sources of oil to enhance national prosperity, which provides the foundation for national power. Two recent events have heightened the nation's awareness of the significance of this dependence: the 9/11 terror attacks on the World Trade Center in New York City and on the Pentagon and the twin 2005 hurricanes, Katrina and Rita, in the Gulf South. These events exposed the vulnerability of our energy infrastructure - from two very different sources. They have triggered a whirlwind effort to rapidly and definitively identify and implement crucial controls to minimize the impact of the next disaster. A key consideration in this debate is the fact that critical infrastructure in the United States is geographically concentrated. This geographic concentration of critical infrastructure has emerged over several decades for a variety of reasons, including federal policy. Also, it has occurred within a permissive risk environment.

The May 2001 Report of the National Energy Policy Development Group[1] identified systemic vulnerabilities within the U.S. energy infrastructure and provided the backdrop for development of a strategic energy infrastructure. Critical infrastructure in the U.S. is characterized by its national importance, interconnectivity, and private ownership. The events of 9/11, followed by the catastrophic meteorological events of Hurricanes Katrina and Rita, changed the risk environment, drawing attention to the vulnerability of geographic concentration of critical infrastructure. Some analysts recommended that oil infrastructure should be more geographically diversified. This SRP focuses on issues related to the geographic concentration of U.S. oil infrastructure. It will then weigh the advantages and disadvantages of geographic distribution of oil infrastructure, illustrated by a case study of Hurricanes Katrina and Rita. It concludes with recommendations for how industry and the U.S. government can create a less vulnerable infrastructure. [2]

Vulnerabilities and Issues Flowing From Geographic Concentration of the Oil Infrastructure

The U.S. energy infrastructure is vulnerable. This systemic vulnerability begins with sources of cheap oil and is perpetuated through "complex energy devices…built and linked together one by one" over several decades. The systemic vulnerabilities are compounded by an alarming, well-documented, but historically ignored concentration of "energy devices" in a single geographic region. [3] To address some of these vulnerabilities, President George W. Bush directed the National Energy Policy Development (NEPD) Group to provide key

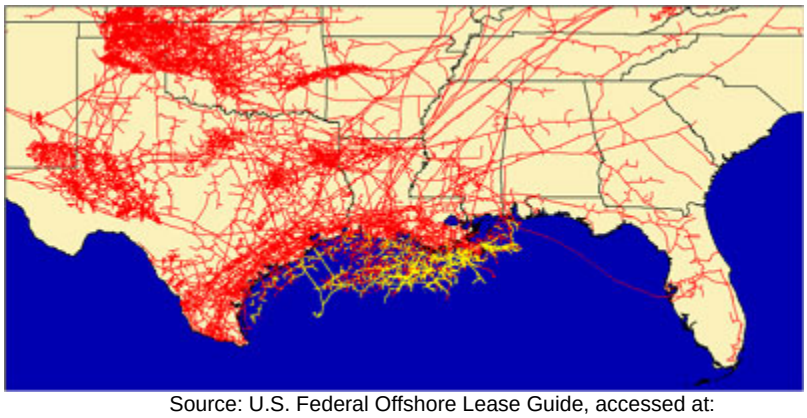
recommendations for development of a more sustainable and resilient national energy infrastructure.

The National Energy Policy Development Group presented three primary energy development challenges: energy conservation; repair and modernization of U.S. energy infrastructure and an increase of energy supplies. To meet these challenges it recommended that the government partner with private industry to gradually overcome the flaws and vulnerabilities of the complex, interactive energy system. Three months later, the attacks of 9/11 dramatically introduced new threats to the nation's national infrastructure and compressed the time requirements for security solutions.

The Department of Homeland Security (DHS) takes the lead in consolidation and evaluation of vulnerabilities and coordination with other federal, state, local, and private entities to ensure the most effective response to national security threats.[4] The National Strategy for the Physical Protection of Critical Infrastructure and Key Assets designates energy infrastructure as critical infrastructure. [5] However, recognizing that the bulk of critical infrastructure and key assets are "owned and operated by the private sector," [6] the strategy simply provides a blueprint for how the federal government could provide energy infrastructure resilience consistent with economic realities often beyond its control.

As we look at a U.S. map, the concentration of our nation's oil infrastructure in a single geographic region makes us uncomfortable. While the industry has built-in safety measures consistent with market realities, these measures somehow don't seem sufficient to withstand threats in a Global War on Terror. The DHS is struggling to fill the security gap and acknowledges that the concentration of oil infrastructure cannot be secured. Industry counters that it is more secure than the government realizes. [7]

Geographic concentration of critical infrastructure can be defined as the physical location of critical assets in close proximity, which unacceptably increases their vulnerability to disruption by the same, or successive, regional events.[8] Over 43 percent of total U.S. oil refining capacity is clustered along the Texas and Louisiana coasts. [9] As illustrated in Figure 1, this density of infrastructure creates the potential for increased consequences from natural or human risks.



Source: U.S. Federal Offshore Lease Guide, accessed at:
http://energy.ihs.com/Products/USFederaloffshorefieldguide/?WBCMODE=pres
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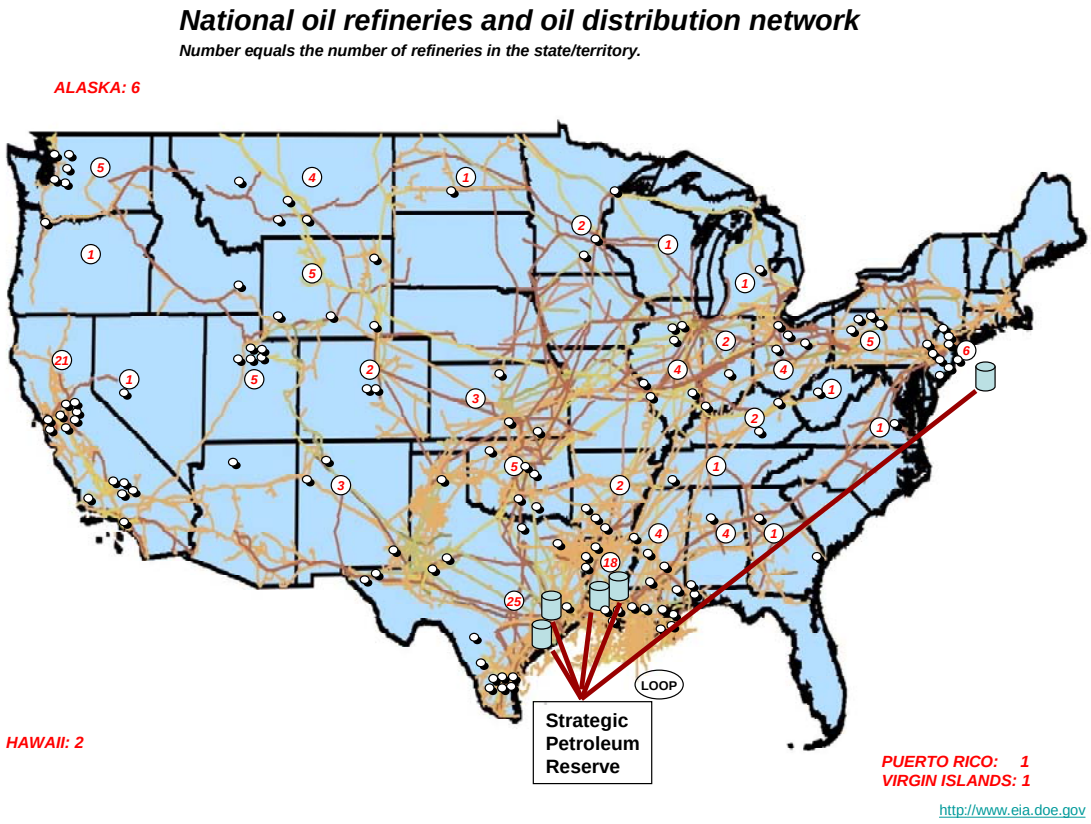
Figure 1. Gulf of Mexico Pipelines and Facilities

Geographic concentration is not new. Five market-driven reasons for geographic concentration are resource location, agglomeration, scale economies, community preference and capital efficiency. Industrial infrastructure locates and coalesces around economic factors of production, which include natural, and human resources as well as supporting infrastructure: ports, pipelines, electricity, and transportation systems. Industry also seeks economy of scale through expanding the capacity of current locations in order to reduce redundancy and overhead expenses. Concentration is also the result of resistance or invitation of local governments through community and tax-based preferences created around local environmental and aesthetic concerns. Finally, industry may consolidate infrastructure to reduce excess capacity and capital expenses.

Much of the oil industry has consolidated in and around the Gulf of Mexico for the above reasons. The corridor along the Mississippi River between Baton Rouge and New Orleans is home to six major refineries. These refineries process more than 1.7 million barrels of oil per day to produce 775 thousand barrels of motor gasoline and 440 million barrels of distillate fuel for heating oil, diesel engines of all kinds, and railroad engines. Louisiana is the primary supply source for the daily shipment of motor gasoline to the East Coast markets through the Capline and Colonial pipelines. The Mississippi River is a convenient natural inland water system and the ports in and around New Orleans provides abundant port facilities and supporting industries. Louisiana and Texas are the only states that have encouraged and accommodated the location of critical oil industry infrastructure within their communities. Figure 2 displays this concentration of oil infrastructure and indicates the outflow of oil from the Gulf South via a network of pipes and rail systems.



Source: Adapted from: http://www.eia.doe.gov/

Figure 2.

Additionally, the nation's Strategic Petroleum Reserve (SPR) is located in four 2,000 feet-deep salt caverns in Louisiana and Texas that contain approximately 755 million barrels of crude oil.[10] While the salt caverns are virtually invulnerable to meteorological hazards and are located in geologically stable locations – meaning they are relatively immune from earthquakes -- the distribution network shares the hazards of the same above-ground distribution infrastructure as the rest of the oil industry in the Gulf Coast.

In addition to market factors, government partnership with industry can also promote geographic concentration. For the past two decades, deregulation has combined with low industry profits to push the industry into consolidation. Due largely to environmental regulations at the end of the second half of the twentieth century, it became cheaper to expand existing refineries than to build new ones. The Department of Energy reports that in 1981, the US had 324 refineries with a total capacity of 18.6 million barrels per day; today, there are only 132 oil refineries with a capacity of 16.8 million barrels per day.[11]

Government and industrial partnership takes many forms. The most common form of such partnerships include prescriptive siting, economic incentives, and regulation. Prescriptive siting requires the establishment of government contracted, owned, and operated industry at a specified location – normally on government property. Private companies are rarely prescriptively sited by the federal government. However, the government does offer right-of-way on federal property. Examples are the Trans-Alaska Pipeline Authorization Act of 1973 (P.L. 93-153) and energy corridors prescribed by the Energy Policy Act of 2005. Other recent examples of federal siting encourage the building of oil refineries on closed military sites.[12]

Economic incentives promote the development of infrastructure where it otherwise would not be built. Incentives include loan guarantees and investment tax credits; they have been useful in the past for expanding and geographically diversifying the nation's infrastructure.[13]

Congress has also taken action to restrict or discourage expanded development in specific locations through regulation. For example, oil production in the continental shelf has been stopped due to potential local economic and environmental impacts. Other examples of Congressional intervention include the Coastal Zone Management Act of 1972 (CZMA, P.L. 92-583) and the Clean Air Act of 1970 (CAA, P.L. 91-604). These acts discourage development or impose restrictive regulations in some locations, thereby encouraging industrial development to migrate to more accommodating locations. Frequently, these economic and regulatory requirements restrict from developing in the manner and location where it makes economic sense to do so.

Private industry functions within the context of market forces, wherein the dynamics of supply and demand are reflected in prices and profits. Profits compensate owners of capital for the funds they have invested in the industry, including compensation for geopolitical and regulatory risks inherent to the oil industry. These risks include war, terrorism, and the countless environmental requirements for boutique fuels.[14] While oil industry profits have been the target of recent political posturing, oil profits are historically low by industry standards: between two and twenty-five percent. [15] For that reason, high volume at low cost is imperative. The price of oil is important to refiners and consumers - and to the efficient functioning of the global oil markets. While high oil prices impact the economics of citizens and countries, oil prices act like traffic signals directing the flow of oil within the global marketplace.[16] U.S refineries compete with refineries worldwide for inexpensive oil. Historically, the cheapest source of oil has been the Middle East.[17]

As newer U.S. refineries have become more efficient, older refineries have been closed. Fewer refineries have resulted in lower inventory holding, which in turn has lowered inventory

costs. The drawback of lower inventories is that they reduce the supply buffer. In a tight market, "it only requires a relatively small amount of oil to be taken out of the system to have huge economic and security implications." [18] A tight market compounds the effects of supply disruptions and multiplies the risks associated with concentrated infrastructure.

Geographic concentration leads to extraordinary exposure to the effects of natural or manmade hazards. Risk can be assessed in terms of the scope (breadth), scale (depth), frequency (probability), and impact (cost) of damage to the infrastructure and the economy. The most common hazards to critical infrastructure are meteorological events, earthquakes and tsunamis, infectious diseases, and insurgency/terrorism. [19] Major meteorological events include hurricanes, floods, ice storms, and tornados that disrupt the operation of critical infrastructure due to physical destruction or through displacement of workers. The effects of Hurricanes Katrina and Rita on the infrastructure and the economy of the energy infrastructure are exemplary. While catastrophic hurricanes are high scope, high scale, high cost events, they are historically rare and highly unpredictable, making it difficult for industry to plan preventive and recovery efforts solely around the potential for future catastrophic events. [20]

Of all hazards, terrorism is the most difficult to guard against in terms of scope, scale and frequency. Terrorist attacks are calculated to inflict the greatest economic and human cost possible, and Al Qaeda seeks opportunities to attack the hinges of the world's economy, "that is, its critical infrastructure." [21] Concentration of infrastructure is particularly inviting to terrorist cells. Cyber attacks that disrupt automated command and control networks would have the same impact as disruption of the electrical grid. Biological attacks can have the same impact as epidemics. A nuclear bomb on New Orleans could simultaneously kill most of the inhabitants and critical oil workers, flood the city, destroy oil industry command and control centers, stop Mississippi river traffic, isolate petroleum workers from their homes and plants, and destroy ports and refineries, thereby shattering the U.S. economy. The scope, scale, frequency and location of terrorist events are more uncertain than hurricane prediction. Concentrated infrastructure serves to magnify that threat and compound the effects of a catastrophic event.

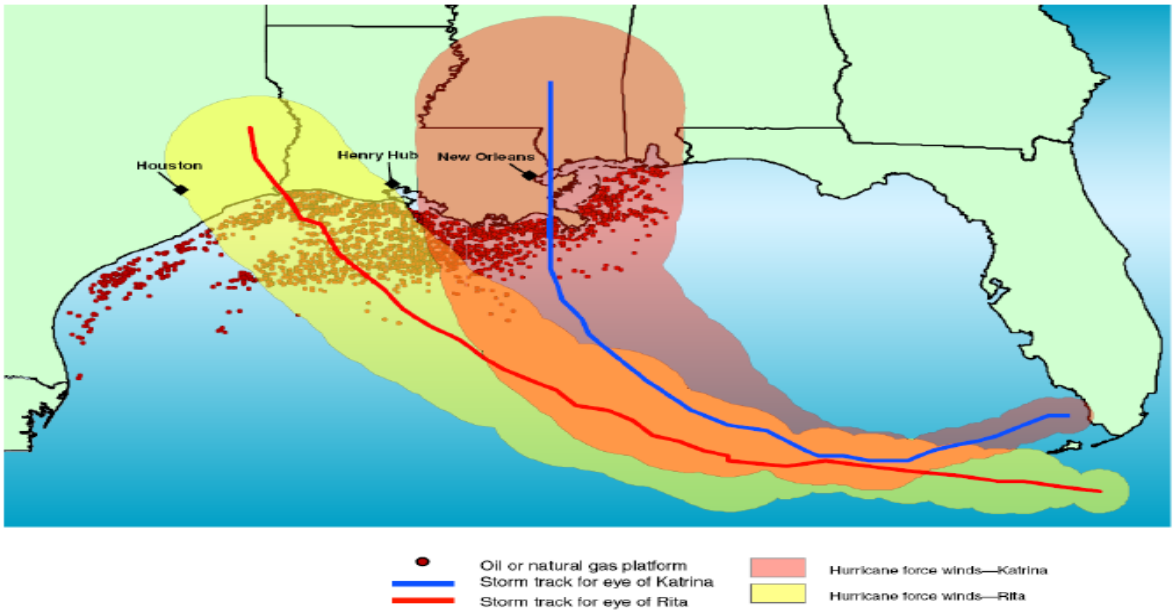
The impact of hazards is measured by the time and cost of infrastructure replacement and repair, [22] which influence decisions concerning geographic location. Large oil refineries cost $4 billion to $6 billion; [23] they take 10 to 15 years to build and much of that time is spent in obtaining environmental permits. Then they last 20 to 30 years. [24] Additional billions are spent on upgrading existing refineries to comply with federal and state environmental regulations. For example, California refineries invested approximately $5.8 billion to upgrade their facilities to

produce cleaner fuels, including reformulated gasoline and low-sulfur diesel fuel. Similar expenditures are being made for the development and marketing of ethanol.

The cost of energy disruption increases with the length of the disruption, as the rising price of oil and oil products ripple throughout the economy. [25] While concentrated infrastructure clearly provides substantial economic and social benefit for industry, government, and citizens, it also produces distinct challenges and vulnerabilities. The U.S. oil infrastructure has become concentrated in a geographic location of acceptably predictable and economically reasonable risk. A more diversified infrastructure could not produce the same amounts of energy for the same costs to consumers. Moreover, greater infrastructure diversity may expose oil infrastructure to greater hazards while reducing industry's ability to mitigate, respond, and recover from disaster.

Oil Infrastructure Concentration Case Study: Hurricanes Katrina and Rita

What Wall Street is to money and Hollywood is to movies, Louisiana is to energy.[26] Hurricanes Katrina and Rita became the costliest ($75 billion) and among the deadliest (nearly 2,000 human lives lost) hurricanes in U.S. history.[27] Specifically, they created considerable damage to a wide range of energy infrastructure along the Gulf of Mexico. [28] Figure 3 reveals the travel pattern of the two hurricanes and the scope of impact on oil and natural gas platforms.



Source: Government Accountability Office, "Natural Gas: Factors Affecting Prices and Potential Impacts on Consumers" (GAO-06-420T), February 2006.

Figure 3.

During the hurricanes, the loss of the electrical grid was the largest disrupter of petroleum production. Government - sponsored consequence management also created problems. For

example, the heightened local security conditions initially prevented industry response teams from accessing refineries and inspecting damage to pipelines and terminals. Emergency generators were necessarily monopolized by the humanitarian efforts and initially denied to the industry by federal and local emergency response supply priorities. Despite these challenges, unprecedented private sector cooperation and unity of industry effort combined to produce the assets (security, communication, alternative [rail] transportation, power poles, and emergency generation) to begin restoring power. Electrical power was restored to 85 percent of the industry within 14 days of Katrina's landfall and within 14 days of Rita's landfall, supporting follow-on recovery efforts.

Pipeline operation requires power and oil volume; the hurricanes deprived critical oil pipelines of both.[29] Electrical restoration had to be timed with supply restoration to overcome the "shut-in" capacity (oil inventory within the pipeline not yet processed).[30] Again, despite overwhelming challenges, by early September most pipeline components were back online and operating at near-full capacity.

On 26 September 2005, the White House reported that 100 percent of oil production in the Gulf of Mexico was shut-in. Hurricane Katrina reduced oil supplies to U.S. markets by 1.4 million barrels per day; Hurricane Rita dropped oil supplies 1.5 million barrels per day.[31] Four thousand offshore platforms were in the direct path of both hurricanes; crews evacuated the platforms and operations were suspended. The hurricanes interrupted operations at all platforms and damaged, dislocated, or sank 200 of them. The Louisiana Offshore Oil Port (LOOP), which receives ultra-large oil shipments of over one million barrels per day, was shut down – its electrical power shut off. Once again, despite these complications, oil operations were restored within a relatively short time frame (November 2005) and 50 percent of normal Gulf oil production was restored.

Until oil production and processing was restored along the Gulf Coast, the domestic production delivery system was circumvented. The Strategic Petroleum Reserve (SPR), in coordination with the International Energy Agency (IEA)[32] and the Global Oil Reserve Coordinating Council, provided 20.8 million barrels of oil and gasoline (2 million barrels per day) through sales and exchange agreements with U.S. refineries beginning on 29 September 2005. Refined oil products came from European reserve stocks, and crude oil was pumped from the SPR storage in Big Hill, Texas (a 72 million barrel facility) and Bayou Choctaw (a 169 barrel facility 12 miles southwest of Baton Rouge) – two of the smallest U.S. oil reserve facilities.

Gulf Coast oil refineries affected by Katrina represent 31 percent of national production. [33] Much of the reduction resulted from precautionary shut-downs. After partial recovery from

Hurricane Katrina, Hurricane Rita hit Texas refineries returning the 30 percent U.S. oil deficit that had resulted from Katrina.[34] In spite of fears of total collapse, most of the refineries were returned to operation with the restoration of electricity. By October 2005, the refined oil deficit was reduced to 3 million barrels per day.[35] Two weeks later the shut-in capacity was only two million barrels. Then by the year's end total shut-in capacity was 189 million barrels - 5 percent of U.S. total or 9 days of total U.S. production.[36] While the sustained reduction in refinery capacity remains at five percent, the oil production recovery was significantly quicker and more complete than most analysts anticipated.

The Advantages and Disadvantages of Geographic Concentration of Oil Infrastructure

Three lessons relevant to the issue of geographic concentration of oil infrastructure may be taken from the impact of Hurricanes Katrina and Rita: while geographic concentration is a source of vulnerability, it also enhanced infrastructure recovery; domestic oil infrastructure must be viewed within a global context; and contemplation of infrastructure modification or relocation requires a unified effort from both government and industry.

While the oil infrastructure was overwhelmed by the compounded impacts of the two hurricanes, it did recover quickly. Consequent infrastructure vulnerability studies flowing directly from the twin hurricanes, however, have recommended that "we should consider the feasibility and cost of diversifying the geographic distribution of U.S. refinery capacity, and the benefits (such as reduced risk of supply disruption) that would come from doing so."[37] While infrastructure concentration provided a dense target, it also aided industry response and recovery. Dr. Dismukes from the Center of Energy Studies at Louisiana State University provides convincing evidence that geographic concentration of oil infrastructure in the Gulf Coast was the key to the rapid recovery of the industry post hurricane [38]

International global oil reserves offer a complementary geographic and portfolio diversity to the U.S. oil infrastructure. With the support of the International Energy Administration, 60 million barrels of oil and gasoline were imported from Europe to seaports and oil markets in the Northeast until oil flows from the Gulf Coast were restored one week later. Additionally, the U.S. Strategic Petroleum Reserve loaned 13.2 million barrels and offered to sell an additional 30 million barrels of crude oil to downstream refineries to help ensure the continuity of energy supplies for drivers, businesses, and the entire American economy. While this is not ideal response from the standpoint of national oil independence, overall risk to the domestic oil infrastructure must be considered within the global perspective.

Hurricanes Katrina and Rita exposed significant capability gaps in U.S. federal interagency processes. [39] The lack of federal, state, and local interagency awareness and cooperation prevented an effective and coordinated response to the twin disasters. The deficiencies observed during the storms could detract from the federal government's efforts to develop and execute its infrastructure modernization and security agendas. The concept of unity of effort is central to every strategic-level document written for resolution of U.S. energy vulnerability, so the lack of unity of effort becomes a critical, systemic vulnerability to effective planning and execution of interagency and public industry remedies to infrastructure concentration.

Unity of effort, however, has been difficult to achieve. Moreover, the lack of unity of effort denies the nation the optimal balance between security and economics. The Department of Homeland Security (DHS) has the responsibility to assess risk factors and produce critical infrastructure strategies to mitigate risks. The National Strategy for the Physical Protection of Critical Infrastructure and Key Assets [40] (CI/KR) clarifies the public and private sector's roles and responsibilities for critical infrastructure and key asset protection. While assuming responsibility for strategic CI/KR, [41] it acknowledges that

> Customarily, private sector firms prudently engage in risk management planning and invest in security as a necessary function of business operations and customer confidence. Moreover, in the present threat environment, the private sector generally remains the first line of defense for its own facilities. [42]

At the same time that the CI/KR asked private industry to reassess the security of their infrastructure and operations, the DHS was developing a parallel assessment protocol to capture private sector inputs and integrate them with federal intelligence to produce security requirements for critical industry infrastructure and infrastructure operations. The process of combining these products that reflect the divergence of security perspectives has been challenging. A look at the difficulties of addressing oil pipeline safety alone provides instructive insight into unity of effort shortfalls.

Since 9/11, the DHS has supplanted the Department of Transportation (DOT) (previously responsible for pipeline safety) as the responsible authority for pipeline security and pipeline safety. The shotgun marriage between pipeline safety and pipeline security is not yet complete. Both organizations view national oil pipelines through separate lenses: the Office of Pipeline Safety (OPS) focuses on safety while the Transportation Safety Administration (TSA) focuses on transport security issues. Industry views safety and security as two sides of the same coin: "Safety and security are interdependent…the distinction is one of intent to do damage."[43] Private industry views terrorism as catastrophic vandalism and prefers to address it through federal

enhancements to consequence management routines. The DHS seeks security through infrastructure hardening measures that industry finds ineffective, unnecessary, and cost prohibitive. For example, what company would assume responsibility and pay for security guards on shared and open infrastructure?

Both OPS and TSA have updated assessment protocols and worked to clarify their respective roles and responsibilities.[44] Some progress has been made. However, the Government Accountability Office (GAO) has found fault with OPS's assessment program. The GAO finds that OPS assessments are incomplete and do not provide clear objectives, strategies or measures of effectiveness. On the other hand, Congress has criticized TSA for its sparse allocation of resources.[45] Without a comprehensive assessment system, the appropriate allocation of resources is impossible. A comprehensive assessment system must incorporate security and safety objectives in general and by geographic distribution specifically. It must also reconcile the tension between federal authority and business sovereignty and acknowledge the primacy of market forces in achieving the desired security and stability of critical infrastructure.

The oil industry generally resents the intrusion of federal assessments that interfere with industry efficiency and, therefore, with profits. Industry pipeline operators are concerned about the prospects of redundant and conflicting regulatory regimes under different agencies. Further, they worry about the scope, scale, frequency, and utility of pipeline assessments foisted on them by "teams from government stumbling over each other to inspect pipes." [46] Industry argues, and studies validate, that they do very well on their own.[47]

Beyond their apprehensions about the intrusion of federal assessment criteria, oil-hosting states worry about "federalism, particularly where federal policies affecting infrastructure dispersion may supercede local infrastructure priorities." [48] Local infrastructure owners (states and local municipalities) have a vested financial interest in existing concentrations of critical infrastructure and resist unrecoverable business expenses.

A second source of federal and industry disparity revolves around the DHS mandates for hardening the oil infrastructure. The oil industry is generally skeptical of costly hardening approaches and the governmental assessment approaches that are used to justify them. Industry cites the difficulty of identifying which measure, or system of measures, will produce a decisive result. Because the oil infrastructure is a global network, it cannot be uniformly protected, which reduces the value of U.S. site-specific security measures. Additionally, back-up measures are themselves subject to the same vulnerabilities as the system they are backing up. Finally, the ability to predict disruptive events, even aided by historical guidance, is complex

and unreliable; the predictability of a terrorist event is the most uncertain of all potential disruptions. [49] For these reasons, targeted infrastructure "hardening has questionable benefits and runs at high cost, which cannot be completely captured in the market."[50] Clearly, while both government and industry have taken numerous steps toward the goal of cooperative integration, "federal activities in these areas are evolving and agency responsibilities are still being sorted out," [51] which leaves a significant gap in security measures.

A third source of oil industry resistance is in the protection of proprietary infrastructure information. The oil industry has proven "politely resistant" to voluntary participation in DHS infrastructure assessments and threat modeling while seeking government intelligence and threat information. [52] Industry prefers to make security decisions itself and invites the federal and state government to assist in providing what industry cannot economically recover. This assistance includes law enforcement, threat intelligence, and robust disaster recovery services.[53] From the oil industry's perspective, national security should not be the burden or responsibility of the private sector.[54]

The federal government is doing what it believes is required on its part to close the security gap. On 9 January 2007, the DHS released an update to the Infrastructure Protection Program (IPP). [55] The IPP provides five grant programs for "a range of preparedness activities, including strengthening infrastructure against explosive attacks, preparedness planning, equipment purchases, training, exercises, security management and administrative costs." [56] The IPP upgrades also reaffirmed DHS's commitment to risk-based solutions by unveiling a more simplified, refined, and strengthened risk assessment approach. While DHS employees close to the oil industry welcome the grant upgrades, some contend that not enough money has been allocated to make infrastructure-hardening actions already in progress truly effective. They worry about the quality of industry security personnel and note that, while technology applications have increased, they haven't added to the overall security posture. What is needed to more fully promote infrastructure protection is more qualified and motivated response personnel. However, these grants do not fund security personnel.

In opposition to infrastructure hardening and geographic distribution, the oil industry values the virtues of infrastructure resilience and recovery enhanced by geographic concentration. Dismukes believes that the best approach to reduce oil infrastructure vulnerability in the future is to expand the industry's response and recovery capabilities:

> refinement of existing protocols, additional pre-staging of equipment and fuel, black-start[57] capabilities for on-site generation and better communications equipment….Government should facilitate quick movement of people back into

> sites, perhaps remove restrictions for housing for those that are working in these critical energy assets.[58]

While advocating for a more geographically balanced energy infrastructure from a security perspective, DHS employees close to the oil industry agree with Dismukes' assessment of greater resilience through response and recovery. They encourage the greater strategic stockpiling of emergency response equipment and supplies. DHS employees close to the oil industry also seek such additional security measures as facility access barriers, wider shipping lanes, more law enforcement and security personnel, improved intelligence sharing, and civil support. [59]

In an effort to mitigate concentration vulnerabilities, federal policy has also incorporated elements of geographic distribution of oil infrastructure. The Energy Policy Act of 2005 provides prescriptive geographic siting for the gas industry. Likewise, the Gasoline for America's Security Act of 2005 (H.R. 3894)[60] provides for the construction of geographically distributed oil refineries for the Armed Services, expansion of the Northeast heating oil reserve, and expansion of the Strategic Petroleum Reserve. HR 3894 also provides for "two new funds to cover certain costs incurred by energy firms." As of March 2007, the SPR has added two billion barrels of heating oil reserves at four locations in northeast U.S. Additionally, a fifth SPR crude oil site in Hattiesburg, Mississippi, farther inland from the Gulf of Mexico, brings additional diversification and a one billion barrel total SPR capacity.[61]

While these federal approaches may provide some measure of security, their net impact is uncertain. Choices must be made about protection priorities given the overall risk. Indeed, as this research has shown, the unity of effort required to produce a risk-based allocation decision making approach equal to this task is still evolving. Until such a system is developed, the most effective and efficient means of securing the domestic energy infrastructure may be to follow the lead of the market and industry. In the broader scope of federal risk management, government must understand the limitations of infrastructure-hardening approaches.

Furthermore, it is imperative that the web of local, state, and federal regulations that have contributed to the geographic concentration of oil infrastructure be reviewed against the existing threat level from a holistic perspective with the objective of creating a more resilient infrastructure network. These same analysts suggest that elimination of all subsidies would allow market forces to work most effectively.

> Energy issues are made up of billions of small pieces which are mainly perceived, chosen and regulated at the local level. Institutional barriers – ten thousand obsolete building codes, obsolete lending regulations and utility practices, and the like – are generally at the state, county or local level. [62]

To address the issue of infrastructure concentration, the private sector, the federal government, and state and local agencies need to take steps to better coordinate their activities."[63] For this reason, existing government policies, along with legislation addressing energy infrastructure in general, and oil infrastructure specifically, must be measured against their collective effects on geographic infrastructure concentration to determine whether the benefits of the additional infrastructure are outweighed by the exposure to geographic hazards.[64]

Some analysts argue that government intervention in infrastructure concentration is not necessary because the private sector will build its infrastructure in accordance with its own economic interests. Dismukes agrees: "Industry should handle these issues primarily since they have the best economic incentive to do so and can do so at the least cost. " Additionally, infrastructure requires a lot of money over a sustained period of time and assumes considerable risk and uncertainty. These commitments involve market dynamics that can become skewed by government interventions. [65]

A key responsibility of the federal government is the promotion of energy preparedness by raising the consciousness, expertise, public accountability, and interagency coordination of federal agencies whose decisions shape the national solution. The oil-consuming public, the demand side of the market solution, must also be engaged in a meaningful way. The primacy of market solutions at the domestic and global levels is cited by many knowledgeable writers. They point out that market forces and energy security are not incompatible.[66] The task of policy-makers, therefore, is not to replace markets but rather to understand, monitor, and make use of market forces in addressing the disruptions associated with emergencies and in framing conditions that encourage the healthy functioning of markets over time.[67] With this in mind, governments at all levels must now review the collective inputs of myriad existing and future policy regulations and incentives to assess their relevance and their contributions to the issue of infrastructure concentration.

The Report of the National Energy Policy Development Group of May 2001[68] called for the modernization of U.S. energy infrastructure. It provided the backdrop for strategic energy infrastructure development through increased deregulation. The National Strategy for the Physical Protection of Critical Infrastructure and Key Assets called for "an unprecedented level of cooperation throughout all levels of government, with private industry and institutions, and with the American people to protect our critical infrastructure and key assets from terrorist attack" [69] The U.S. has a long road to travel before this level of cooperation is achieved.

Consideration of this issue of geographic concentration of oil infrastructure illustrates the complexity of the homeland defense issue.

Geographically concentrated infrastructure can be dispersed, replicated with redundant infrastructure, hardened in place, or restored after a disaster. All of these options are costly. They take a long time to execute and are of questionable security value. The challenge to government and industry in making a decision is first to understand the risks of geographic concentration. To do this, the geographic dimension (economic geography) must be factored into the broader infrastructure management and decision-making process.

> National security, therefore, requires not only that we calculate the probability of foreseeable kinds of failure. Our designs must also include the broader philosophy of resilience in the face of the incalculable: lunatics, guerillas, Middle East wars, freak winters, social turmoil, and those unpredicted high-technology failures…an implicit readiness for unforeseeable and imponderable threats. [70]

This challenge is complex both systemically and politically. Systemic complexity persists because of diverse hazards (and their compounding interactions) and political complexity prevails because of the resilient market factors and government actions underpinning the current infrastructure configuration. Once again, until all of these factors can be captured and knowledgably and deliberately assessed, the market may provide the best, though imperfect, solution to oil infrastructure distribution.

The value of redistribution and expansion of domestic oil infrastructure to reduce risks to oil infrastructure security cannot be demonstrated. Conversely, it is clear that oil infrastructure concentration can contribute to the reduction of overall oil infrastructure vulnerability, whereas redistribution and expansion of domestic oil infrastructure may increase the overall risk profile. The more critical vulnerability, however, is the apparent inability to achieve the unity of effort required to sort out the interagency, governmental, and industrial issues for an effective and sustainable solution.

Recommendations

Based upon the foregoing research and analysis, the following recommendations are designed to strengthen private sector and government efforts to protect our essential energy infrastructure:

First, DHS should support infrastructure resilience and recovery by providing more robust federal recovery stockpiles and aid as required and requested through state-level DHS employees. This aid may include, but not be limited to, facility access barriers, law enforcement and security personnel, and greater intelligence-sharing. Additionally, grants should support the

staffing of private industry with security personnel in addition to technological solutions (cameras, sensors, and others). A grant designed to provide industry-focused security training for key industry personnel would facilitate the development of training experts, similar to military security and weapons training experts. This grant should include specific funding to allow these training experts to perform follow-on emergency response drills to validate the effectiveness and quality of the training, and assess the capability of industry personnel to respond to future disasters. An additional funding initiative designed to foster joint industry and federal personnel training would further enhance infrastructure resilience and improve unity of effort.

Second, as federal initiatives under the Energy Policy Act of 2005 for modernization of oil infrastructure move forward, they must be assessed against the vulnerabilities created by geographic concentration for both federal agencies and private industry. [71] This requires the formation of a common language, common objectives, and common threat picture. A common threat picture will require the sharing of proprietary information from both industry and government sources. Without more effective dialogue and greater trust, protracted stalemates and road blocks are unavoidable. The FY2007 Infrastructure Protection Program may provide the needed security bridge by strengthening DHS's ability to protect security and business-sensitive information.[72]

Third, America must reduce its dependence on fossil fuels. Increasing dependence on oil as the nation's primary energy source only increases oil vulnerability and exponentially expands the country's inability to mitigate supply shock. The initiatives outlined in the Energy Policy Act of 2005 form the basis of a public education campaign. These recommendations require further funding and heightened national focus to attract the attention of American citizens and to foster individual efforts to reduce energy consumption.

Fourth, a "9/11 surcharge" should be applied to gasoline and home-heating oil to fund additional security requirements that are not currently met through the Congressional budget and industry market pricing mechanisms. [73]

> Security is not free. Both the public and private sectors need to invest in building a higher degree of security into the energy system – meaning that energy security will be part of both the price of energy and the cost of homeland security.[74]

The surcharge should support the expansion of DHS grant funding for access barriers to facilities for law enforcement and security personnel. Additionally, it should provide funds for aggressive research and development of fuel/energy alternatives.

Conclusion

The nation's energy infrastructure is vulnerable. One vulnerability is presumably the concentration of oil infrastructure in the Gulf of Mexico. After the shock of 9/11 and the energy disruptions caused by Hurricanes Katrina and Rita, many analysts questioned this geographic concentration of oil infrastructure and called for geographic dispersion. However, the suggested remedy of redistribution may actually increase overall systemic vulnerability and be prohibitively expensive. The balance between oil infrastructure security, the industry's resilience and the nation's economic viability requires a unity of effort not yet demonstrated between government and industry. The Report of the National Energy Policy Development Group of May 2001 and the Critical Infrastructure Protection Plan of 2006 propose specific recommendations to eliminate energy infrastructure flaws and provide opportunities for government and industry to consider issues of infrastructure concentration. Appropriate and sustainable solutions to oil infrastructure location will require federal and state governments to assess, reconcile, and coordinate government regulation and incentives that shape market forces that contribute to infrastructure location. These solutions must be designed within the context of the global oil industry and the new risk and threat environment. In this way, the solutions will yield a more complete, comprehensive, and sustainable approach to risk management that may provide a greater return on security dollars.

Endnotes

[1] Department of Energy, *Energy Policy Act of 2005*, available from http://www.energy.gov /about/EPAct.htm - 68k; Internet; accessed 13 Oct 2006.

[2] Scope and Limitations of this SRP. Oil infrastructure concentration has counterparts in other critical infrastructure sectors. To limit the boundaries of the paper I will focus on the issues and remedies of concentrated infrastructure within the domestic oil industry. Where risk profiling is used or referred to, no attempt is made to definitively quantify risk variables or predict risk events.

[3] Amory B. Lovins and L. Hunter Lovins, *Brittle Power: Energy Strategy for National Security, (*Andover, MA: Brick House Publishing Co., Inc, 1982), 2. Armory Lovins is a physicist who approaches the issue of sustainable oil from a scientific context. This book flows from his earlier work, "World Energy Strategies, Facts, Issues and Options, New York, 1975. Lovins identifies the scientific and therefore systemic vulnerabilities of a fossil-fuel based energy system, like the one that has developed in the U.S. over decades. His thesis is that the current energy framework is unsustainable and inherently vulnerable. He seeks a more resilient system -- not more resilience in an unsustainable system. A resilient system would have a diversity of sustainable energy sources.

[4] General Accountability Office. GAO-06-91 *Risk Management, Further Refinements Needed to Assess Risks and Prioritize Protective Measures at Ports and Other Critical Infrastructure* (Washington, D.C.: U.S. General Accountability Office, Dec 2005), 20.

[5] Office of the President, *The National Strategy for the Physical Protection of Critical Infrastructure and Key Assets* (Washington D.C.: U.S. Government Printing Office, Feb 2003). The National Strategy for the Physical Protection of Critical Infrastructure and Key Assets lists critical infrastructure as information technology, telecommunications, chemicals, transportation, emergency services, postal and shipping services, agriculture and food, public health and healthcare, drinking water and water treatment, energy, banking and finance, national monuments and icons, defense industrial base, key industry and technology sites, and large gathering sites.

[6] Ibid, Executive Summary, x.

[7] Governments and the oil industry share a symbiotic, and sometimes antagonistic, relationship. Daniel Yergin explains in two books: *The Prize, The Epic Quest for Oil, Money and Power* (New York: Free Press, 1991) and *The Commanding Heights, The Battle for the World Economy* (New York: Touchstone, 2002). Like it or not, oil has become the seminal source of global economic and political power; a "commanding height." *The Prize* focuses on the growth and myriad impacts of the oil industry both domestically and globally. *The Commanding Heights* describes the evolving role and political challenges of state, national and global governments in managing markets and human affairs as globalization accelerates. Taken together, they provide the political, economic, and social backdrop behind the question of the concentration of oil infrastructure.

[8] Paul W. Parfomak, *Vulnerability of Concentrated Critical Infrastructure: Background and Policy Options* (Washington, D.C: Library of Congress, Congressional Research Services, Dec 2005).

[9] Ibid. According to Parfomak, the following critical infrastructure sectors exhibit geographic concentration: Transportation (marine cargo) - nearly 32 percent of U.S. waterborne container shipments pass through the ports of Long Beach and Los Angeles in southern California; Agriculture and Food (livestock) – approximately 27 percent of U.S. hog inventories are located in Iowa (another 16 percent of hog inventories are located in the eastern counties of North Carolina); Public Health and Health Care (pharmaceuticals) – approximately 25 percent of U.S. pharmaceuticals are manufactured in Puerto Rico, primarily in the San Juan metropolitan area; Banking and Finance (securities market) – nearly 46 percent of U.S. securities are traded on the floors of the New York and American Stock Exchanges in lower Manhattan; approximately 22 percent of U.S. security industry employees are located in New York City; Transportation (rail) – over 36 percent of U.S. freight rail cars pass though Illinois, primarily around Chicago; nearly 25 percent of freight railcars pass through Missouri, primarily St. Louis; Defense Industrial Base (shipyards) – over 31 percent of U.S. naval shipbuilding and repair capacity is in and around Norfolk, VA; Louisiana hosts 15 percent of the defense shipbuilding industries. Alternative metrics include the impact on GDP as demonstrated in the oil supply disruptions discussed in "Strategic Petroleum Reserve, Available Oil Can Provide Significant Benefits, but Many Factors Should Influence Future Decisions about Fill, Use and Expansion," Report to Congressional Requestors, U.S. Government Accountability Office (GAO-06-872) of Aug 2006.

[10] David Stoltz, e-mail message to author, 31 Jan 2007. The U.S. seems to require two billion barrels of oil reserves. The U.S. consumes 20 million barrels of oil per day, produces eight million barrels of oil per day, and imports the balance: about ten million barrels of oil per day. The oil reserve requirement of the International Energy Agency (IEA) is 90 days of oil import coverage. Current capacity is equivalent to approximately 60 days of import coverage – 30-days short of the 90-day requirement. President Bush announced in his State of the Union address in Jan 2007 that the SPR capacity will be doubled. But that does not mean an additional million barrels of oil in reserve. The SPR is being expanded to a fifth site near Hattiesburg, Mississippi raising the total capacity to one billion barrels, and possibly to a second site in Hattiesburg (a sixth SPR site) in the future, for a total of one and one-half-billion barrels. The SPR justifies the lesser amount by explaining that the two-billion barrel requirement is only true if all imports were cut-off. "It is highly unlikely," says Dave Stoltz of the DynMcDermott Petroleum Operations Company Public Affairs and Planning Office, "that all imports would be cut off since we receive oil from so many different sources. IEA rules do say 90-days but the interpretation of what 90-days consists of is left to the country (to determine)." Current SPR inventory can be viewed at http://www.fossil.energy.gov/programs/reserves/index.html.

[11] Mark A. Clayton, "A Push to Build New Refineries," *The Christian Science Monitor*, 21 Sept 2005, available from http://www.csmonitor.com/2005/0921/p11s02-usec.html, Internet; accessed 15 Jan 2007.

[12] Armed Forces Information Service, "Bush Proposes Oil Refineries on Closed Military Bases", Wash D.C. 27 Apr 2005, available from http://www.defenselink.mil/ news/Apr2005/20050427_785.html; Internet; accessed on 15 Jan 2007.

[13] Parfomak, *Vulnerability of Concentrated Critical Infrastructure: Background and Policy Options*, 14.

[14] Controlling fuel composition to achieve emission reductions is often one of the most cost effective control measures. The Clean Air Act (CAA) requires certain national standards be met for gasoline quality for the purpose of protecting public health. However, in areas that have special air quality needs, the CAA allows states to adopt unique clean fuel requirements, and to sell gasoline that is specially formulated to meet the air quality needs. Locally, many individual oil refiners work with local and state air quality officials to create cost-effective fuels programs that meet local air quality needs. Such locally-specific fuel types are referred to as "boutique fuels." Available from http://www.epa.gov/oms/boutique.html; Internet; accessed 03 Feb 2007.

[15] Federal Trade Commission. *Gasoline Price Changes: The Dynamics of Supply, Demand, and Competition*, (FTC.gov 2005). This document is an excellent tutorial on the economics of oil and gasoline prices.

[16] In a fully functioning marketplace (operating under laws of supply and demand with no government intervention or price controls), high demand for a product without corresponding supply results in high prices. High prices signal a profit opportunity, drawing resources to where they are needed.

[17] Richard Gibson. *Some Interesting Oil Industry Statistics*, available from http://www.gravmag.com/oil.html; Internet; accessed on 03 Feb 2007 "On average, U.S wells produce just 17 barrels per day. In contrast, a typical Saudi well generates 12,000 barrels per

day. If we drilled 700 typical U.S. wells, the Saudis could simply shut down one well and the world input would remain flat – there would be not price impact on the world oil market."

[18] Robert M. Gates, Oil Shockwave National Security Advisor, *Oil Shockwave, Oil Crisis Executive Simulation*, available from http://www.secureenergy.org; Internet; accessed on 07 Dec 2006.

[19] Parfomak, Vulnerability of Concentrated Critical Infrastructure: Background and Policy Options, 5-7. Earthquakes pose great risk to concentrated infrastructure and storage and distribution hubs and networks. The chart below indicates seismic activity along the Pacific coast from 1974 through 2003. Earthquakes can impact all or some of the critical transportation and distribution infrastructure and geological activity has damaged the Trans-Alaska pipeline on several occasions. Concentration of oil infrastructure in the Gulf of Mexico, however, limits exposure to the risk of damage from earthquakes.

Earthquakes, Magnitude 3.5 and Greater, 1974 - 2003

1	Alaska	12,053	57.20%
2	California	4,895	23.20%
3	Hawaii	1,533	7.30%
4	Nevada	778	3.70%
5	Washington	424	2.00%
6	Idaho	404	1.90%
7	Wyoming	217	1.00%
8	Montana	186	0.90%
9	Utah	139	0.70%
10	Oregon	73	0.30%
11	New Mexico	38	0.20%
12	Arkansas	34	0.20%
13	Arizona	32	0.20%
14	Colorado	24	0.10%
15	Tennessee	22	0.10%

Tsunami risk to the U.S. seems remote. Concentration of oil infrastructure along the Gulf Coast decreases the risk profile of this type of meteorological event. Epidemics and pandemics of infectious diseases restrict the movement of critical personnel and workers. While a potential risk exists for this type of threat, geographic concentration or dispersion would not likely alter the impact of epidemic or pandemic threats.

[20] *Uncertainty: Solutions dealing with Uncertainty*, available from http://hurricanes.noaa.gov/prepare/title_uncertainty.htm; Internet; accessed on 2 February 2007.

[21] Daniel Yergin, "Ensuring Energy Security," *Foreign Affairs*, 85 (May/Jun 2006), 70.

[22] Parfomak, Vulnerability of Concentrated Critical Infrastructure: Background and Policy Options, 14. A Congressional Research Study presents the following table of selected events over 15 years which shows a clear pattern of nearly annual catastrophic events exceeding $1 Billion (see below).

Year	Event	Location	Cost
2005	Hurricanes (Cat 4,3)	Gulf of Mexico	70 b
2004	Hurricanes (Cat 2,3,4)	Florida, Alabama	45 b

2003	Hurricane (Cat 3)	Mid-Atlantic	3.4 b
2003	Epidemic (SARS)	Ontario	.8 b
2001	Terror attacks	New York, VA, PA	83 b
2001	Tropical Storm	Texas, SE U.S.	5 b
1998	Ice Storm	Quebec, NE U.S.	1.4 b
1997	Flood/Tornados	Ohio/Mississippi Valley	1b
1996	Hurricane (Cat 3)	N. Carolina	3.2 b
1995	Flood/Tornados/Hail	S Central U.S.	5.5 b
1994	Ice Storm	SE U.S.	3 b
1994	Earthquake	California	26+ b
1993	Flood	Midwest	21 b
1992	Hurricane (Cat 5)	Florida, Louisiana	26.5 b

[23] Peter Van Doren and Terry Taylor, "High Pump-Price Fairy Tales," *Cato Institute*, 4 June 2005 available from http://www.cato.org/pub_display.php?pub_id=3792; Internet; accessed 31 Oct 2006.

[24] Lincoln P. Bloomfield, ed., "Global Markets and National Interests, The New Geopolitics of Energy, Capitol and Information," *Center for Strategic Studies*, Significant Issues Series 24, No. 3 (2003).

[25] Lovins, 308-309.

[26] Robert J. Samuelson, "How Will Katrina Impact U.S. Economy?" *Newsweek*, Sept 12, 2005 available from MSNMC.com; Internet; accessed on 29 Nov 2006 and Paul J. Hibbard, *US Energy Infrastructure Vulnerability, Lessons From the Gulf Coast Hurricanes,* Analysis Group, Economic, Financial and Strategy Consultants, Boston Massachusetts, Mar 2006, 7.

[27] "Katrina and Rita One Year Later: Ecological Effects of Gulf Coast Hurricanes, Ecological Society of America," *Science Daily*, 7 Aug 2006; available from http://www.sciencedaily. com/releases /2006/08/ 060807155009.htm; Internet; accessed on 13 Oct 2006.

[28] Kristi A.R. Darby, David E. Dismukes and Seth E. Cureington, *Hurricanes and Energy Infrastructure in the Gulf of Mexico: Impacts and Challenges*, Louisiana State University, Center for Energy Studies, Baton Rouge, LA (Extended Abstract), available from http://www.searchand discovery. com/documents/2006/06086gcags_sec_abs/images/abstract.darby.et.al.pdf; Internet; accessed on 17 Oct 2006.

[29] David Dismukes, e-mail message to author, 21 Nov 2006. "The east coast supplied by the Colonial Pipeline was down to two days of available gasoline post-Katrina." See also www.enrg.lsu.edu

[30] Shut in: In the oil industry, "shut-in" capacity refers to oil (refined or unrefined) that is held within the pipeline or distribution system and cannot be accessed, a production cap set lower than the available output (of an oil producing site) available from http://en.wikipedia.org/wiki/ Hurricane_Katrina; Internet; accessed on 15 Jan 2007.

[31] The White House, Fact Sheet: *President Bush Discusses Energy Supplies in the Gulf Region*, 26 Sept 2005, Available from http://www.whitehouse.gov/news/releases /2005/09/print/20050926-1.html; Internet; accessed 17 Jan 2007.

[32] The International Energy Agency (IEA) was formed after the 1973-74 oil crises. Energy security is the core of IEA activity. The IEA has 26 member countries. Each is committed to maintain national emergency oil reserves and plans for coordinated stock draw-down and reallocation of supplies when necessary. Net oil importing countries have a legal obligation to hold emergency oil reserves equivalent to at least 90 days of net oil imports of the previous year. Available from http://www.iea.org; Internet; accessed 13 Oct 2006.

[33] David E. Dismukes, *Interdependence of Critical Energy Infrastructure Systems*. Presentation at the Woodrow Wilson Center: Cross Border Forum on Energy Issues on Oct 12-13, 2006 in Washington, D.C., available from http://www.enrg.lsu.edu/presentations/; Internet; accessed on 21 November 2006. Hurricane Katrina impacted U.S. refinery capacity as follows: 15 percent loss from Gulf Coast refineries; 5 percent loss from inland Lake Charles and Port Arthur; and 10 percent loss from up-line Midwest refineries serviced by Capline.

[34] Ibid. Hurricane Rita impacted U.S. refinery capacity as follows: 10 percent loss at Gulf Coast refineries; 13.5 percent loss from Huston and Texas City refineries; 4 percent loss from Corpus Christi refineries; and 2 percent reduction from up line Midwest refineries (338 million barrels per day), Energy Information Administration, Department of Energy.

[35] David Dismukes, e-mail message to author, 21 Nov 2006.

[36] Ibid.

[37] Two analysts are featured here. Hibbard's (see Hibbard, 5.) analysis is "long" on problem definition and "short" on substantive options: while suggesting that the issue of geographic concentration requires risk assessment, the author does not say how this could be done or who should conduct the assessment. Bruce L. Peck, Jr. in *The U.S. Strategic Petroleum Reserve: needed changes to counter today's threats to energy Security*, Strategic Research Project (Carlisle Barracks: U.S. Army War College, 3 March 2006) suggests modifying the Strategic Petroleum Reserve in terms of size (1 billion barrels), portfolio (adding jet fuel, refined gasoline and heating oil) and location (Northern and Southern California) without reference to added physical security or market risks.

[38] David E. Dismukes, "The Impacts of the Recent Hurricane Season on Energy Production and Infrastructure Outlook," Presentation before Industrial Energy Technology Conference, 2006, New Orleans, LA, May 9, 2006 available from http://www.enrg.lsu.edu/presentations; Internet; accessed 12 Oct 2006.

[39] "A Failure of Initiative," Final Report of the Bipartisan Committee to Investigate the preparation for and Response to Hurricane Katrina (U.S. Government Printing Office, Washington D.C. Feb 2006) in U.S. Army War College, National Security Policy and Strategy, 3 AY (2007): 141-162.

[40] Office of the President, *The National Strategy for the Physical Protection of Critical and Key Assets* (U.S. Government Printing Office, Washington D.C. Feb 2003).

[41] Ibid, vii.

[42] Ibid, x.

[43] Paul W. Parfomak, Pipeline Security: An Overview of Federal Activities and Current Policy Issues (Washington, D.C: Library of Congress, Congressional Research Services, Feb 2004) 20.

[44] The American Petroleum Institute provides regular updates to its infrastructure assessment protocols. An updated "Security Vulnerability Assessment Methodology for the Petroleum and Petrochemical Industries, Second Edition was published on Oct 2004 followed by "Security Guidelines for the Petroleum Industry" six months later on April 2005. Both documents are impressive and demonstrate the seriousness of the petroleum industry in engaging the changing threat environment.

[45] Daniel K. Inouye, opening statement of the Senate Committee on Commerce, Science and Transportation, hearing on the president's FY2006 Budget Request for the Transportation Security Administration (TSA), Feb 15 2005 in CRS -11 of Apr 2006. "Aviation security has received 90 percent of TSA's funds and virtually all of its attention. There is simply not enough being done to address . . .pipeline security."

[46] Parfomak, *Pipeline Security: An Overview of Federal Activities and current Policy Issues*, 20.

[47] Telephonic and e-mail correspondence between the author and DHS employees close to the oil industry, between November and January 2007, indicate that the quality of the relationship between industry and law enforcement is inconsistent. The overall assessment from these sources is that industry security is "lackadaisical" and the law enforcement is disinterested, in general. The message that industry seems to be sending is that if the federal government wants more security than the market will bear, than it must produce the people to fill the gap.

[48] Parfomak, *Vulnerability of Concentrated Critical Infrastructure: Background and Policy Options*, 18.

[49] Gordon Woo, "The Viability of Terrorism Risk Modeling: A Five-Year Retrospective, *Risk Management Solutions*, Edinburgh (May 22-24, 2006): 2.

[50] Dismukes, e-mail message to author, 21 Nov 2006.

[51] Parfomak, *Pipeline Safety and Security Federal Programs*" of 11 Oct 2006.

[52] E-mail communication between the author and DHS employees close to the oil industry on 15 Jan 2007 revealed that the "oil industry as a whole has been unwilling to contribute financially to the regional homeland security (Joint Marine Ops Center, Public/Private Partnerships, boat barriers)…The oil industry…is very protective of its proprietary information and has not (so far) been willing to participate voluntarily (industry participation is not required at this point) in our risk assessment modeling…"

[53] This industry perspective was consistent with multiple sources and validated through telephonic and e-mail communication between the author and DHS employees, close to the oil industry, between November 2006 and January 2007. These sources shared their concerns about the quality of industry security personnel and barrier plans. Maritime shortfalls included on-water assets for response, access barriers, wider shipping lanes and more pre-positioned assets to recover from an infrastructure disaster and oil infrastructure redundancy out of the Gulf Coast (i.e. North America).

[54] Lovins, in "Brittle Power" is clear about elements of the historic relationship between the oil industry and the government that have resulted in the infrastructure vulnerabilities discussed in this paper. He cites the preparedness planning by the Department of Defense between 1978 and 1980 that resulted in dollars earmarked for energy saving programs which was ultimately redirected to other uses. In short, any government solution to energy vulnerability must result from the significant reorientation of government thinking: from preventing curtailment (disruption) to reducing dependence.

[55] U.S. Department of Homeland Security, *Overview: FY 2007 Infrastructure Protection Program*, (U.S. Government Printing Office, Washington D.C. 9 Jan 2007).

[56] Ibid, 1. These grants include Transit Security Grants ($178 million), Port Security Grants ($201 million), Intercity Bus Security Grants ($12 million), Trucking Security Grants ($12 million), and Buffer Zone Protection Program Grants ($49 million).

[57] A black start is the process of restoring power after a wide-area power outage has occurred.

[58] Dismukes, e-mail message to author, 21 Nov 2006.

[59] DHS employees close to the U.S. oil industry acknowledged to the author that oil infrastructure security requires both infrastructure redundancy and resilience. While greater redundancy of infrastructure "to the north" would "release the geographic pressure," infrastructure hardening (higher quality of guards, dogs, and fences) and resilience (increased response, redundancy and recovery capacity) were required near term.

[60] H.R. 3893--109th Congress (2005): *Gasoline for America's Security Act of 2005*; Available from http://www.govtrack.us/congress/bill.xpd?bill=h109-3893; Internet; accessed 24 Jan 2007. H.R. 3893 would authorize new programs and spending related to the supply and use of petroleum and other energy products. It would provide subsidies to small refineries, make certain federal lands available for siting new refineries, and revise the terms and procedures for approving these and other energy projects. Available from http://www.cbo.gov/showdoc.cfm?index=6686& sequence=0; Internet; accessed 24 Jan 2007.

[61] Stoltz, e-mail message to author, 31 Jan 2007.

[62] The findings of Lovins' book, published in 1982, remain current today. The authors begin by describing how the U.S. energy structure was established by diverse Secretaries of Energy, who have continued, incrementally and unknowingly, to increase the vulnerability of America's energy system. A key assumption underpinning this energy structure has been that the Armed Forces would, somehow, be able to defend whatever system is built. The authors assess the

current system as unsustainable, and argue instead for the development and introduction of energy alternatives.

[63] Yergin, "Ensuring Energy Security," 79.

[64] Parfomak, *Pipeline Security: An Overview of Federal Activities and Current Policy Issues*, 21.

[65] Stephen A. Brown and Richard Alm, "Running on Empty? How Economic Freedom Affects Oil Supplies", *Economic Letter – Insights from the Federal Reserve Bank of Dallas, Federal Reserve Bank of Dallas,* 1 (Apr 2006).

[66] Yergin, "Ensuring Energy Security," 80.

[67] William F. Martin, Ryukichi Imai and Helga Steeg, "Maintaining Energy Security in a Global Context," *The Trilateral Commission*, New York, September (1996):104.

[68] Department of Energy. *Energy Policy Act of 2005*, available from www.energy.gov/ about/EPAct.htm - 68k; Internet; accessed 13 Oct.

[69] The White House. *The National Strategy for the Physical Protection of Critical Infrastructure and Key Assets*, (The White House Press, Feb 2003): 1.

[70] Lovins, 29.

[71] The National Commission on Energy Policy. *Ending the Energy Stalemate: a Bipartisan Strategy to Meet America's Energy Challenges*, Dec 2004, p 90. Provides recommendation for the development of threat simulation design tools for analyzing prevention, response and recovery from accidental or malicious interference in the functioning of major energy systems or facilities.

[72] U.S. Department of Homeland Security. Overview: *FY2007 Infrastructure Protection Program* (U.S. Government Printing Office, Washington D.C. 09 Jan 2007): 1.

[73] For a detailed discussion of the impact of additional outlays on the projected 2007 – 2017 budget, see Congressional Budget Office (CBO), "The Budget and Economic Outlook." Current government revenues do not meet outlays. Additionally, economic growth alone is unlikely to cover current entitlement programs (Medicare, Medicaid and Social Security). "…either a substantial reduction in tax revenues relative to the size of the economy or some combination of spending and revenue changes will be necessary to promote the nation's long-standing fiscal responsibility."

[74] Yergin, "Ensuring Energy Security," 79.