Strategy Research Project

ENERGY DEPENDENCE: THE $1.4 TRILLION ADDICTION THREATENING NATIONAL SECURITY

BY

LIEUTENANT COLONEL MARK TOWNE
United States Army Reserve

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U.S. Army War College, Carlisle Barracks, PA 17013-5050

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Lieutenant Colonel Mark Towne
United States Army Reserve

Professor Douglas Johnson, Ph.D.
Project Adviser

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U.S. Army War College
CARLISLE BARRACKS, PENNSYLVANIA 17013

ABSTRACT

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ENERGY DEPENDENCE:
THE $1.4 TRILLION ADDICTION THREATENING NATIONAL SECURITY

America's addiction to oil is a threat to economic well-being, national security, and international stability. The cost of oil impacts every economy in the world. Approximately 70 percent of the oil consumed in the U.S. is used in transportation.[1] The use of oil is most visible to consumers not simply in the retail price of gasoline but in the cost of all goods and services throughout the economy.

Oil is a commodity currently without an economically competitive substitute. Nations and organizations with the ability to control the production and distribution of oil have considerable leverage in the international system and over social behavior writ large. The U.S. expends enormous assets to ensure secure access to supplies and global markets. Oil addiction is bleeding the nation of its economic wealth and degrading the standard of living of the American people. If this condition persists, oil usage will destabilize the international system and challenge the ability of the U.S. to protect its national interests.

The threat oil addiction poses to America's national security is both real and complex. Policy makers have failed to develop a common understanding of the problem let alone to seriously engage the American people. Until policy makers arrive at a common understanding of the issues associated with oil addiction, efforts to craft a coherent policy and implement an integrated strategy that mitigates the national security threat will not be successful.

The lack of a coherent policy and integrated strategy has led the U.S. to pursue disparate initiatives in an attempt to reduce oil dependency. The nation's policy

objectives are not driving comprehensive strategic ends, ways, and means capable of resolving the security threat posed by oil addiction. A properly aligned energy policy and strategy would deliver market solutions, promote popular support, and generate the political will necessary to successfully repair the growing problem.

Oil: the Critical Vulnerability of America's Center of Gravity

The Center of Gravity is "the hub of all power and movement, on which everything depends."[2] Military and diplomatic elements of national power contribute significantly to the security of the U.S., but the economy is the center of gravity. The U.S. has the largest and strongest economy in the world.[3] In 2008, the U.S. Gross Domestic Product (GDP) was $14.4 Trillion.[4] For the last 30 years, the U.S. Defense budget has averaged 5.5 percent of GDP and 4.8 percent for the last five years.[5] A healthy economy provides the foundational strength of all the other elements of national power.

Clausewitz aptly described how the strength of a nation is rooted in the concerns and interests of the people, the military, and the government. This is commonly referred to as the "Trinity."[6] Sound national leadership maintains balance among the Trinity elements, particularly during times of stress. Exceptional economic power provides the opportunity for the U.S. to pursue increased productivity and a higher standard of living. The economic well-being of the people provides the strength and capacity of the government to serve the nation. Economic strength makes possible the means for a strong national defense. In short, it is the strength of the economy that balances the Trinity and ensures national security and stability.

Critical Capabilities of the Economy. In order for an economy to prosper and gain strength, four factors have to work effectively: "property rights, scientific

rationalism, effective capital markets, and efficient transport and communication."[7] "The absence of even one of these factors endangers economic progress and human welfare; kicking out just one of these four legs will topple the platform upon which the wealth of the nation rests."[8] The ability to secure the nation's center of gravity hinges on the protection of critical requirements associated with each factor. Failure to do so puts the entire economic system in danger of collapse.

Critical Requirements for Transportation. There are several nodes in the transportation value chain that are essential if the system is to operate effectively: (1) a secure fuel source, (2) stable supply routes, (3) cost-effective fuel production capacity, and (4) an extensive distribution infrastructure. A critical vulnerability is any weakness that threatens the nodes and has the potential to compromise the system. Fuel is necessary to make the transportation system run. Any threat to fuel availability puts the system at risk.

Critical Vulnerabilities: Oil is the most common source of transportation fuel and, at present, there is no economically viable substitute. The price elasticity of demand is therefore very low. Any disruption, perceived or real, in the oil supply, shocks the system and threatens the transportation and energy industries. In order to protect the center of gravity and reduce vulnerability, a commercially competitive oil substitute is necessary.

Developing a Common Understanding of the Problem

Reliance upon foreign oil is not an immediate threat to the U.S. The danger comes from the increasing competition for the global oil supply. The U.S. is the 3rd largest producer of oil in the world.[9] Americans also consume and import more oil than any other nation.[10] In 2008, the U.S. imported more oil than Japan, China and

Germany combined. The U.S. also consumed more oil than Russia, China, India, and Japan combined.[11] As global demand increases, and economic growth in India and China expand, market competition will continue to inflate oil prices. Merely increasing domestic oil production will not solve this problem. As a fungible product, oil can be delivered anywhere in the world in response to consumer demand. Price per se is determined by its variety and global supply and demand, not the origin of the commodity. Having no market-competitive alternative exacerbates the problem. "Disruption in oil supplies anywhere can affect oil prices everywhere." [12] Competition for secure sources of oil in the growing global market continues to create economic and political instability throughout the international system.

The Global Threat: Control and Access. Much of the oil market instability derives from "state-controlled national oil companies (NOCs) [who] hold most of the oil and gas reserves. The six largest NOCs have ten times the reserves of the top six privately owned companies." [13] Privately held, publicly owned companies are dependent on the free-market for their survival and distribute most of the fuel used by U.S. consumers. The NOCs, however, are government owned and can control the supply of oil they provide based on national interests instead of what is required to promote market stability.

In addition to the NOCs' direct influence on global oil prices, distribution to market adds considerably to price instability. The daily supply of oil requires movement through regions that are not politically or economically stable. In fact, over half of the daily global oil supply moves through six maritime choke points. The two most critical choke points are the Strait of Hormuz and the Strait of Malacca through which over 30

million barrels of oil are shipped every day.[14] The choke points expose the global oil supply to interdiction or even closure, threatening conditions that have potentially devastating consequences as even a temporary blockage "…can lead to substantial increases in total energy costs."[15]

The security threat to the U.S. and the international system can come through interdiction of production facilities and supply routes by terrorists, pirates, or shipping accidents, as well as natural disasters anywhere in the world. Without an alternative to oil, the U.S., and any country dependent on international trade, will continue expending substantial resources to ensure the sources of production, choke points, and oil supply routes, remain secure.

The Domestic Economic Threat Posed by Oil. The U.S. has imported oil for decades in response to the demands of American consumers. Since 2004, both the quantity of oil consumed and the price of fuel has dramatically increased. The U.S. spent over $1.4 Trillion on imported oil in the last five years.[16] The detrimental effect on the U.S. economy continues to grow with consequences that will be long lasting and devastating.

The effect of continuing to import oil is substantial when considered in the overall context of the U.S. trade deficit and the downward pressure importing oil applies on the GDP.[17] Oil imports accounted for 26 percent of the U.S. trade deficit in 2004. In 2008, oil imports accounted for over 60 percent of the deficit.[18] The $1.4 Trillion required to import oil over the last five years constitutes a massive transfer of wealth away from American consumers to oil producing nations that, in many cases, do not share U.S. values or interests.

The financial impact of importing oil was $1.4 Trillion that was unavailable to stimulate the U.S. economy via consumption, investment, or job creation and generate tax revenues. Individual consumers may find it difficult to grasp the devastating impact oil imports are having on lost GDP.[19] Stagnant economic growth, however, manifests itself in constraints on consumer purchasing power. Consumer cash flow and purchasing power is directly affected by increasing gas prices and the fuel charges imbedded in the cost of goods and services. The nominal cost of gasoline increased 2 percent from 1979 to 1999. From 2000 to 2008, the nominal cost of gasoline rose 117 percent.[20] Increased fuel prices drive up the cost of food, surcharges for delivery services, airline industry fees, and additional transportation related expenses.

The escalating cost of importing oil is stagnating economic growth and there is no expectation for relief in sight. American's can expect to see imported oil expenditures ranging from $2 to 6 Trillion over the next 10 years.[21] This vast wealth will transfer to other oil producing nations because the U.S. does not have a commercially ready substitute for oil. Without an alternative fuel for transportation, the U.S. economy will continue to suffer staggering economic drag.

Another barrier to solving the U.S. addiction to oil is the length of time it will take to implement any viable solution. If a commercially viable substitute for oil were introduced in the market today, it would not solve the need to rely on imported oil for quite some time. Internal combustion engines (ICE) would have to be phased out over time as consumers transition to vehicles powered by alternative fuels. The transition to other automobile technologies will take time because "less than 7% of the auto fleet is replaced each year."[22]

Recapitalizing the transportation sector of the economy will be expensive and require decades. Private and public sector leaders will have to reassure consumers that the cost and time to transition the economy from oil are worthwhile and achievable. Public demand will not support solutions that cost more and fail to produce effective results. Commercial acceptance will be impacted by the cost and market timing of the different components of the transportation value chain, especially the producers, distributors, and consumers of the alternative fuels and new vehicle technologies. A challenge to successfully introduce any alternative fuel and vehicle technology to the market is synchronizing the value chain. Synchronization is essential to ensuring that projected consumer demand will be supported by the availability of vehicles with the new technology and infrastructure that can provide the necessary supply of alternative fuels, both of which have to reach the market simultaneously.

The value chain also has to be cost competitive to ensure the fuel, distribution network, and automobile manufacturers can compete with the mature oil based technologies. It is difficult for any emerging alternative fuel technology to compete with an established industry. The oil industry has been developing markets since 1861[23] and barriers to entry are substantial. The monopolistic trust characteristics of the industry prevent any alternative from being competitive when it first enters the market. Only a coherent governmental policy will break down the barriers and free the nation from addiction to oil.

Currently, it is not in the interest of the oil industry to allow alternative fuels to compete fairly in the transportation market. Temporary public-private sector partnerships are necessary to promote production and consumer demand capable of

breaking the strangle hold the oil industry has on the transportation fuel market. The nation has to make a choice: continue the dependence on oil and ignore the growing threat to national security, or promote public-private sector partnerships that will generate an alternative fuel industry capable of competing in the open market.

The Approach to Strategy Formulation

Former Chief of Staff of the Army, General Peter J. Schoomaker, often cited a key lesson learned from the disaster of Operation Desert One with the phrase, “don’t confuse enthusiasm with capability.” Confusing enthusiasm with capability produces tragic results. There is a lot of enthusiasm for different alternative fuels that appear to have the potential to reduce the nation’s dependence on oil. Care must be taken to temper public and political enthusiasm for technology investments that waste resources in an effort to reduce overall oil consumption.

Any solution that will realistically eliminate the nation’s addiction to oil has to meet the transportation demands of consumers. Solutions that fail to meet the driving requirements of consumers will backfire in favor of oil. The automobile industry has analyzed the market and concluded that transportation demand segments exist as a function of vehicle size and driving range. Figure 1 depicts how different technological solutions meet disparate driving habits of consumers. Solving demand in partial market segments may reduce oil consumption but does not eliminate the underlying and significant security threat. Technologies that reduce demand for oil have to meet the cost, size, and performance requirements across market segments if the solution is going to be viable. In short, the need for ground transportation is not going away. The vehicles and fuels people use to travel and move goods will have to change in order to solve the problem.

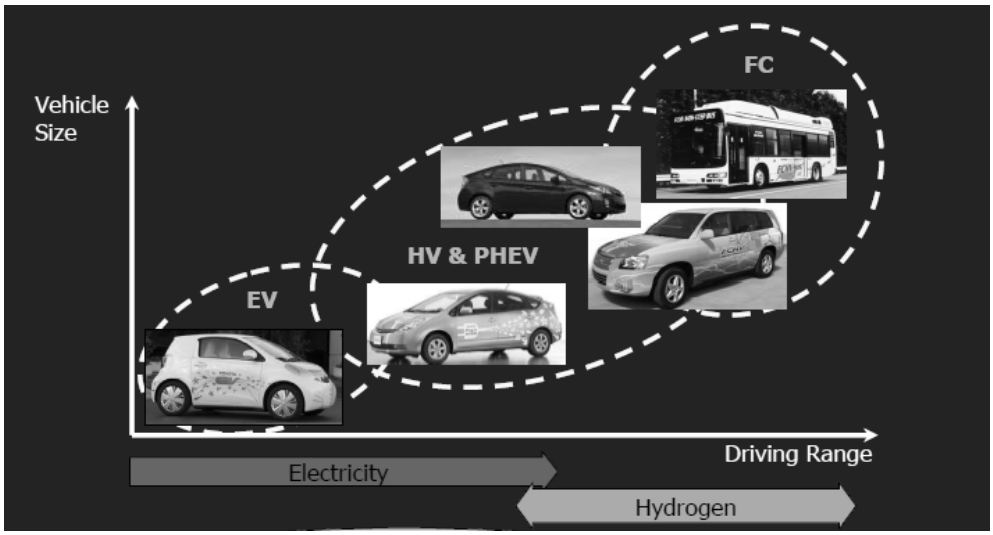

Figure 1: Toyota Motor Company North America Market Segmentation[24]

Status of Current Strategic Ways and Means

Several emerging technological advances have the potential to lower the demand for oil. They include: (1) flex-fuel vehicles and ethanol fuel blends; (2) hybrid gasoline-electric vehicles; (3) plug-in hybrid electric vehicles; (4) battery electric vehicles; and (5) hydrogen fuel-cell vehicles.

E85 Biofuel.[25] Advances in biofuel production have resulted in a marketable ICE fuel blend that is 85 percent ethanol and 15 percent gasoline. The fuel is designed for use in flex-fuel vehicles and is slowly gaining consumer acceptance. The retail price of E85 can be higher or lower than gasoline depending on the region of the country where it is produced and purchased. Vehicle performance is similar to an ICE but the mileage per gallon for E85 is 20-30 percent less.[26] Senator Tom Harkin (D-IA) proposed a bill in Congress on August 6, 2009 called "The Consumer Fuels and Vehicle Choice Act." [27] The bill proposes $1 Billion in grants over five years to help private industry install E85 infrastructure. The proposed legislation requires a 50 percent cost share with private

industry and directs the federal government to purchase flex-fuel vehicles in order to increase the demand for E85.

Hybrid-Electric Vehicles (HEV). The HEVs *are* currently in full market production. HEVs use an ICE combined with an electric motor to power the vehicle. The electric motor is powered by a battery that is charged by the ICE and also produces electricity by regenerative braking. HEV performance is comparable to an ICE. Fuel efficiency is better than an ICE but the HEV purchase price is higher. The commercialization of HEVs was successful due to U.S. government tax credits offered to consumers starting in 2006 to help private industry bring HEVs to the market. Once a manufacturer sold 60,000 vehicles, the incentives were phased out.[28]

Plug-in Hybrid Electric Vehicles (PHEV). The PHEV is a technology currently entering the automobile market. The "PHEVs combine an electric motor and internal combustion engine."[29] The battery for a PHEV is charged by plugging it in to the electric grid when the vehicle is not in use. On June 23, 2009, the President of the United States announced the government's commitment to provide $8 Billion in loan guarantees to the automobile industry in order to bring advanced vehicle technology to the market. $1.6 Billion was to help retool manufacturing capacity in order to make PHEVs and develop better battery technology. [30] The U.S. Government also initiated consumer tax credits to stimulate purchases of PHEVs.[31] The next PHEV challenge lies with consumer acceptance of the technology. The limited driving range of PHEVs compared to ICEs, combined with the time it takes to recharge the vehicles, pose significant barriers to consumer acceptance.

Battery Electric Vehicles (BEV). The BEV is the next generation electric vehicle. The BEV receives all of its energy from the electric grid. There is no ICE assist or internal recharging capacity. The industry loan guarantees the President announced on June 23, 2009 included $465 Million to accelerate delivery of BEV's to the market.[32] The greatest challenges with BEVs include limited driving range, recharge time, battery cost, and the weight of the batteries.[33] Battery technology is expensive to develop and produce. Refueling is also not as convenient as an ICE because of the recharge time required for the batteries. Additionally, the number and size of batteries has to increase in order to extend the driving range of BEVs. Increasing the number of batteries or size adds weight to the vehicle and decreases the driving range. BEVs have the potential to meet consumer demand in specific market segments particularly when driving range is not a crucial consideration.

Hydrogen Fuel Cell Vehicles (HFCV). The HFCV has not entered the mass market yet. The benefit of the HFCV is that it does not use any oil. The HFCV uses hydrogen as the on-board fuel source to produce electricity. "A kilogram of hydrogen has approximately the same energy content as a gallon of gasoline."[34] This comparison is a metric referred to as the gallon of gasoline equivalent (GGE). Currently, retail hydrogen costs between $2.10 and $9.10 GGE. As HFCVs penetrate the market, projected retail cost estimates for hydrogen fuel range from $1.75 to $4.25 per GGE.[35] The HFCV provides size, power, and range capability comparable to the ICE. It also "achieves two times the fuel economy of the gasoline ICE."[36] With twice the fuel efficiency as an ICE, gasoline would have to drop to less than $2.13 per gallon to remain cost-competitive with hydrogen.

Hydrogen for HFCVs can be produced from several domestic sources. Most hydrogen production comes from a process called Steam Methane Reformation (SMR).[37] SMR is a thermal process that separates hydrogen from feedstock such as natural gas. Another method to produce hydrogen is electrochemically from water through electrolysis. Hydrogen can also be produced from renewable bio-derived liquids or through biomass gasification.[38]

The greatest challenges to the HFCV are the cost and structural barriers to enter the market. Cost and structure barriers include installing or retrofitting fueling infrastructure and the price of the vehicles when the HFCVs first enter the market. Hydrogen can be produced on site at fueling stations or mass produced and delivered via pipeline or truck. The challenge with the initial retail cost is the same as any other new automobile technology. Substantial market demand is necessary to bring down the end-user price tag.

The HEV, PHEV, and EVs received government loan guarantees and consumer tax incentives to help jump start production and consumer demand. Currently, however, there are few government financial incentives for automobile manufacturers or consumers to bring the HFCV to market. Federal funding for hydrogen fuel technologies was eliminated from the FY10 President's Budget request. However, Congress restored $174 Million for hydrogen technology development.[39] The FY11 Department of Energy (DOE) request to Congress for hydrogen program funding decreased by over 20 percent to $137 Million.[40]

Stakeholder Positions

Each technical solution to decreasing oil dependency has advocates. Each solution also has adversaries that consider other alternatives as competitors that should

be discounted rather than incorporated as complementary components of the larger transportation and energy system. Several alternative fuel efforts have been funded by the federal government across multiple agencies including the Department of Defense (DOD).[41] Those efforts, however, are not driven by a comprehensive U.S. energy strategy capable of eliminating the nation's addiction to oil. Media coverage, that strongly shapes public opinion, has also not been particularly helpful. At times, information provided by the media has been out dated, inaccurate, or out of context about the feasibility of specific solutions.

Federal Government Response. The President of the U.S. has a clear policy objective to rid the nation of its reliance on oil. The current strategy is to "make the investments in clean energy sources that will curb our dependence on fossil fuels and make America energy independent"[42] by promoting "the next generation of cars and trucks and the fuels they run on."[43] The federal government's role in implementing the policy is to set the conditions for industry to bring competitive alternative fuels and technologies to the market. Incentives for introducing hybrid technologies have been highly successful. The problem is, the strategic ways and means advocated by the Administration, do not align with the policy or strategy ends. The Administration and Congress agreed on the need to provide incentives for E85, the HEV, PHEV, and BEVs to jump start these technologies. They do not agree on the HFCV, however. The Administration views the lack of a supporting infrastructure and the time horizon for commercialization of HFCV technology as impractical. The current strategy focuses on commitments to solutions that can be delivered in the near-term while discounting the long-run character of the automobile market. The Congressional decision to restore the

HFCV funding supports the Administration's near-term solutions but does not lose focus on the grand-strategic view for the future of ground transportation. Without the HFCV included as central among the strategic ways to achieve the policy objective, a large segment of the market will continue to hold the nation hostage to oil dependency.

State Governments Response. As early as 2006, 47 states and the District of Columbia were actively pursuing fuel cell and hydrogen legislation and technology development.[44] Many states are partnering with private industry, academia, and the federal government to develop and commercialize alternative fuels. The state of California, for example, has a comprehensive strategy to commercialize electric drive and hydrogen powered vehicles as the mid to long term solution to replace ICEs and oil as a fuel source.[45]

California markets are important in the introduction of any new automobile technologies. Its heavy driving conditions, large population, and consumer demand provide a good test of the viability of new automobile products. Toyota Motor Company and the DOE National Renewable Energy Lab (NREL), for example, used California to demonstrate the driving range of an HFCV Sport Utility Vehicle (SUV). They achieved "an estimated range of 431 miles on a single fill-up of compressed hydrogen gas."[46] The testing in California is important because success there often leads to the nationwide adoption of new technologies throughout the automobile industry. Expanding hydrogen fueling infrastructure and introducing HFCVs in California will stimulate regional consumption and the additional investment necessary to bring the HFCV to commercial markets across the nation.

Public Opinion and the Media. The media plays an important role in the adoption of technology in the market place. Public opinion is critical because it is ultimately consumer behavior that will determine the success of vehicles using alternative fuels. There has not been much controversy in the press regarding the public acceptance of E85, HEVs, PHEVs, and BEVs. There has, however, been some press questioning the viability of HFCVs and the future of hydrogen as a fuel source. Perception is currently drowning out the facts.

Several challenges to the legitimacy of HFCVs and the use of hydrogen as a fuel source have appeared in recently published books and news articles. Some of the challenges have been framed out of context or relied on inaccurate or out-dated information. Examples include describing hydrogen fuel technology as too expensive to produce and distribute, and inequitable comparisons of the final cost to consumers contrasted against established alternatives. Hydrogen technology is often discounted by advocates of HEVs and BEVs because "massive changes to the nation's fuel distribution infrastructure would be required to accommodate hydrogen fuel-cell vehicles." [47] What they do not discuss, however, is how hydrogen use will benefit the nation by reducing oil consumption and GDP drag while stimulating domestic economic growth.

Another example of mischaracterizing the cost of hydrogen lies with the description of the delivered fuel price compared to gasoline. Gasoline has a price advantage because the retail per gallon cost is spread over a large number of customers. If the cost of gasoline was allocated to only a few customers, it would also be extremely expensive. The challenge for any alternative fuel entering the market is

how to jump start demand with an initial customer base large enough to bring down the end-user cost. In order to equitably compare retail hydrogen with gasoline, prices for mature demand of both products provides the more meaningful measure of comparison. In that context, retail hydrogen is very cost competitive with gasoline.

Media ignorance or bias is also a problem in the debate about alternative fuels. An example is a recently published article characterizing the HFCV as "President George W. Bush's pet initiative."[48] The article maintained that advocates of hydrogen technology base their views on "the persistent, hypnotic allure of hydrogen eco-mythology."[49] Unfortunately, when an industry expert wrote the publisher and provided the facts behind hydrogen fuel technology and commercialization, the response never reached the public domain.[50]

Private Industry. Private industry has made tremendous advances in the past few years in HFCV technology and the capabilities to produce, store, and distribute hydrogen. The basic requirement that makes the HFCV more competitive in the long run is the fact that, as Dieter Zetscher, Chief Executive Officer of Diamler, recently stated hydrogen "…beats electric batteries at moving cars long distances without refueling."[51] That vision of the light duty vehicle market based on hydrogen fuel is shared by executives from major automobile manufacturers to include General Motors, Honda, Nissan and Toyota.[52] Toyota, for example, is currently leasing test vehicles powered by hydrogen and plans to introduce their first, commercial market, HFCV in 2015.[53]

What about Other Nations? The energy and automobile industries serve global markets. As the U.S. energy strategy evolves, it is important to understand that

solutions other countries are promoting could affect the global demand for automobile technology and fuel. A competitive advantage exists for nations and manufacturers that collaborate in the technology development and delivery of alternative fuels to the market. The European Union, Germany, and Japan have committed $5.3 Billion of public funding to facilitate manufacturing, operating costs, and infrastructure required to commercialize HFCVs.[54] Germany's energy strategy is to provide public funding to develop a nationwide fueling infrastructure for HFCVs. Nationwide travel by HFCV in Germany will be possible in 2013 and by 2017, they expect to have 1000 fully operational hydrogen fueling stations.[55] As more developed nations adopt hydrogen and become producers of HFCV technology, the U.S. will fall further behind unless a national commitment is made to aggressively reestablish American leadership in the commercialization of hydrogen technologies.

What is the Right Solution and How Do We Get There?

Ensuring open dialogue and support for solutions that will help make policy objectives successful is important. Senator Richard Luger (R-IN) provides wise council for leaders who are serious about the nation's security. In the forward section of *Freedom from Oil, How the Next President Can End the United States Oil Addiction,* Senator Lugar wrote, "Good policy emerges from serious debate, informed by the facts."[56] Unfortunately, that has not happened. The nation is currently pursuing an energy strategy that has the potential to make only marginal progress at best. The reason is because there is a gap between the strategic ways and the means to achieve the policy goal of energy independence.

Analysis: The Gaps between Policy and Strategy

The Administration's Policy. The Administration's energy policy objective provides some direction for eliminating the nation's addiction to oil. Achieving energy independence effectively closes the critical vulnerability oil dependence poses to the economic security of the nation. The gap between the current policy and strategy, however, fails to close the critical vulnerability caused by oil addiction. This puts the U.S. center of gravity and the long term security of the American public in jeopardy.

Components of a Strategy: Proper Alignment of Ends, Ways, and Means. The ultimate goal of strategy is to successfully achieve policy objectives. Any successful strategy necessarily includes the goals that are required to achieve the policy objectives. These goals are commonly referred to as the "ends." The strategic "ways" are the methods or programs required to achieve the strategic ends. The "means" are the resources needed to execute the ways through which to successfully achieve the strategic ends.

Energy Security Strategic Ends. The current Administration's strategic ends are to "promote the next generation of cars and trucks and the fuels they run on." [57] This objective is inadequate. It is too vague to drive strategic ways and means that will successfully meet the policy objective. The language drives interim solutions that may lead to reduction in oil consumption but does not constitute a strategic shift toward energy independence.

Energy Strategic Ways. The strategic ways for providing any alternative to oil involves finding a way to introduce solutions to the consumer market. That does not guarantee the alternative will be successfully adopted by consumers or have an impact sufficiently large enough to eliminate the critical vulnerability that oil dependence poses

to the economy and national security. Two criteria for assessing the ways, or the portfolio of solutions supported by the energy strategy, include: Does the solution cover the market segment capabilities demanded by consumers? Does the solution reduce oil consumption enough to eliminate dependency? If the answer is yes to both questions, then the strategic ends and ways are properly aligned to achieve the policy objective. If the answer is no, the strategy fails. The government's role is to support the ways and provide the means that set the conditions to commercialize solutions necessary to accomplish the policy objective. The current strategic ways have a critical gap because of the lack of federal government emphasis on bringing the HFCV to the consumer market.

Energy Strategic Means. Figures 1 and 2 provide the framework to assess the alignment of the energy policy, strategy, and the national security threat. There is not a single technology that will solve the capability gap. A portfolio of ways that include ICEs with improved gas mileage, market penetration of HEVs, PHEVs, and BEVs, commercialization of hydrogen fuel, and HFCVs, will be required to meet the policy objective and close the critical economic vulnerability oil poses to the nation. Only a portfolio approach with all these solutions will reduce U.S. oil consumption enough to safeguard the economy and eliminate the critical vulnerability.

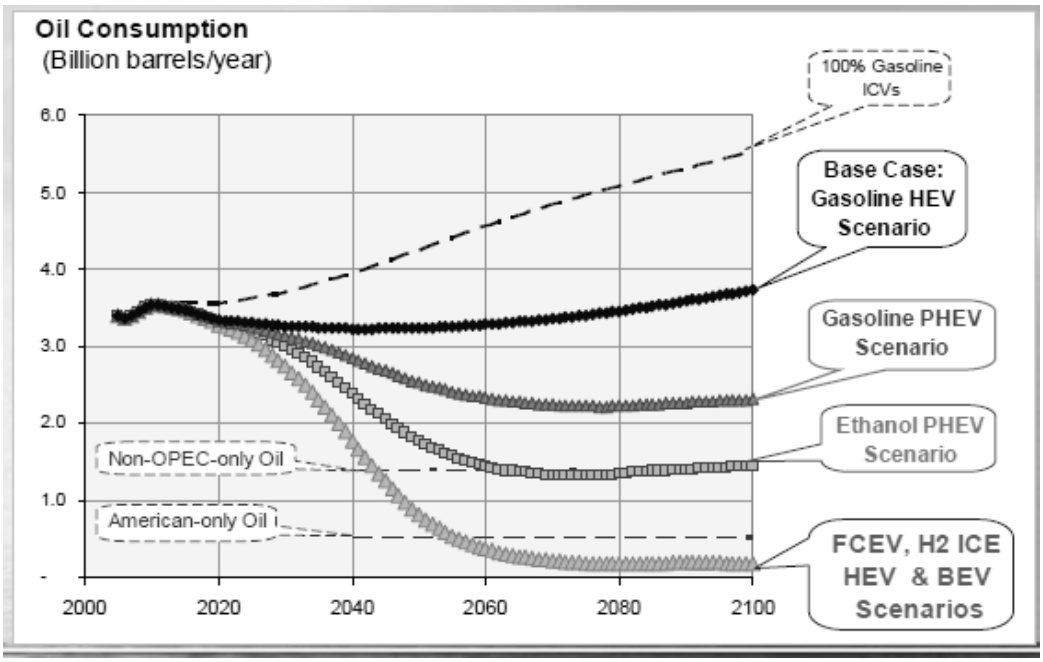

Figure 2: Impact of alternative fuel vehicles on U.S. oil consumption.[58]

The federal government has provided means for the development and commercialization of all of these technologies. The problem is in the declining federal support for HFCVs. Without commercialization of the HFCVs, a large portion of the consumer market will continue to rely on ICEs and oil as a fuel source. Federal resources required to commercialize HFCVs range from $200 Million per year [59] and escalate to a total of $55 Billion[60] over a 15 year period. The investment is a large public commitment but is not without precedent. The subsidy for ethanol fuel for example, was $2.5 Billion in 2006 and could reach $15 Billion per year by 2020.[61] The impact of investing $55 Billion in hydrogen fuel over 15 years will provide a high return on investment to the U.S. economy and national security. Decreasing the lost GDP associated with imported oil will stimulate the U.S. economy by several hundred billion dollars each year. Only a portfolio that includes HFCVs will adequately align the ends,

ways, and means with the policy objective and close the security gap caused by the addiction to oil.

Recommendations

The current U.S. energy policy does not drive an adequate energy strategy to close the critical vulnerability oil dependency poses to the nation. The energy policy should be strengthened by modifying the objective to become an energy independent and exporting nation. The most critical flaw in the current strategy is the failure to emphasize hydrogen as a critical component of the nation's energy portfolio. Zeroing out hydrogen in the FY10 President's Budget sent a message to private industry that the U.S. government is backing away from the technology. The irony is that international partners and private industry continue to move forward. Without the U.S. government support, HFCVs will still get to the market but in other countries. While other nations protect their economies, the U.S. will continue to be increasingly vulnerable.

The U.S. energy strategy should include HFCVs as a vital component of the energy capability portfolio. Federal policy and funding should aggressively pursue public-private partnerships that will bring HFCVs and hydrogen fueling infrastructure to the U.S. market. The U.S. government should provide the means for commercializing HFCVs in the form of loan guarantees, grants, and tax credits, similar to what has proven effective in bringing HEVs to the market.

In addition to including HFCVs in the portfolio of strategic ways, the Administration and Congress should provide the means necessary to support closing the critical gap in the energy strategy. Support and expand the Consumer Fuels and Vehicle Choice Act. Modify the bill to include similar language for hydrogen fueling

infrastructure and HFCV procurement as it does for E85. Add $1 Billion over a five year period as a near term investment to jump start hydrogen fueling infrastructure. Provide grants to states that have the most mature public-private programs. Establish the requirement for the General Services Administration (GSA) and the DOD to procure flex-fuel vehicles and HFCVs for federal organizations that operate in the geographic locations where grants are used to build E85 and hydrogen fueling infrastructure. Develop consumer tax credits similar to what was implemented for the introduction of HEVs in the domestic market. Provide $55 Billion of federal funding over 15 years to support a long term government commitment to develop and commercialize hydrogen distribution infrastructure, fuel cell technologies, and renewable production capacity.

The Role of the DOD. Leverage the DOD expertise in Research, Development, Testing, and Evaluation (RDT&E) and acquisition to lead the nation in the transition from oil. Use the 15 year $55 Billion funding plan to resource joint DOD and DOE programs to take advantage of existing alternative fuel RDT&E and commercialization efforts. The DOD and GSA can create acquisition demand for the HFCV technology to help reduce production and distribution costs.

Strategic Communications. Consumer driving habits and purchasing behavior are critical to the successful implementation of any energy strategy. The U.S. Government should partner with industry to produce a public service announcement campaign that informs consumers about the strategy, the return on investment to the economy, and the security benefits the entire energy portfolio, including HFCVs, will provide to the nation.

Conclusion

The U.S. center of gravity is the economy and it is currently hemorrhaging because of the nation's addiction to oil. The nation has to make a choice. Either take bold steps to stop the hemorrhaging or slowly weaken as economic strength of the nation drifts away. The U.S. has lost over $1.4 Trillion since 2004 and trillions more are on the way out.[62]

Energy independence is a U.S. vital interest. The current energy policy and strategy has a critical gap, however. It does not include the comprehensive ways or means portfolio necessary to protect the nation. Without HFCVs in the portfolio to replace ICEs, the nation will not reduce oil demand sufficiently to eliminate the threat and, thereby, enforce the nation's security. The federal government must take bold action to align policy and strategy that promotes public-private partnerships capable of delivering HFCVs and hydrogen fuel to the commercial market. A 15 year $55 Billion investment to solve the problem may seem high. However, the economic loss and associated threat to U.S. national security if HFCVs are not brought to the commercial market will be much higher.

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