2005 CJCS Strategic Essay Contest Winners 3d

Tanker receiving its payload from Iraq's Al Basrah Oil Terminal

U.S. Navy (Richard J. Brunson)

America's Strategic Imperative
A "Manhattan Project" for Energy

By JOHN M. AMIDON

The American presence in the Middle East stretches back to the closing days of World War II, when President Franklin Roosevelt met King Saud aboard a U.S. warship in the Suez Canal. Through the ensuing 30 years, Washington sought to maintain oil access and contain the Soviet Union by cultivating Persian Gulf allies. The mutually beneficial relationship between the United States and the Middle East oil-producing countries was forever altered by the Yom Kippur War and the subsequent petroleum embargo. The 1973–1974 embargo highlighted the strategic importance of the Middle East and elevated oil access to a core national interest. The end of the Cold War and the rise of Islamic fundamentalism further shifted the security focus from keeping a mutual enemy, Russia, out of the region to fighting much of the war on terror within the region.

Dependence on imported oil, particularly from the Middle East, has become the elephant in the foreign policy living room, an overriding strategic consideration composed of a multitude of issues. In the short term, U.S. options are driven by the imperative to achieve a favorable outcome in Iraq

Lieutenant Colonel John M. Amidon, USAF, wrote this article as a student at the Air War College.

and Afghanistan and on other battlefields of the war on terror, but we must also find a way to extricate ourselves from reliance on the Middle East and other oil-producing countries.

Current energy strategy assumes that this country can meet its oil needs by managing the oil-producing countries diplomatically and militarily. However, this thinking overestimates the available oil supply, ignores growing instability in the oil-producing countries, and understates the military costs of preserving access.

Today's strategy must adopt a more realistic view of the limited available oil and recognize the diplomatic and military costs of obtaining it. If the strategy were to correctly estimate the remaining supply and recognize the cost to the Nation of accessing that oil, it would encourage users to consume less and accelerate development of alternatives. The United States must embark on a comprehensive plan to achieve energy independence—a type of Manhattan Project for energy—to deploy as many conservation and replacement measures as possible.

Current Energy Policy

In May 2001, the National Energy Policy Development Group published the Administration's *National Energy Policy*, which states:

Extraordinary advances in technology have transformed energy exploration and production. Yet we produce 39 percent less oil today than we did in 1970, leaving us ever more reliant on foreign suppliers. On our present course, America 20 years from now will import nearly 2 of every 3 barrels of oil—a condition of increased dependency on foreign powers that do not always have America's interests at heart.[1]

The policy calls for enhanced efficiency in existing domestic oilfields and exploiting heretofore environmentally denied areas such as the Alaska National Wildlife Refuge (ANWR). Although increasing the domestic fraction of our oil consumption is a worthy goal, achieving a meaningful effect will be difficult, given that domestic production is declining at a rate of 1.5 million barrels per day.

The report also urges improved conservation:

A recent analysis indicates that the fuel economy of a typical automobile could be enhanced by 60 percent by increasing engine and transmission efficiency and reducing vehicle mass by about 15 percent. Advanced lightweight materials offer up to 6 percent improvement in mileage for each 10 percent reduction in body weight.

The primary means of increasing automotive economy is through mandated corporate average fuel economy (CAFE) standards.

Responsibly crafted CAFE standards should increase efficiency without negatively impacting the U.S. automotive industry. The determination of future fuel economy standards must therefore be addressed analytically and based on sound science.

Taken in whole, the *National Energy Policy* does not offer a compelling solution to the growing danger of foreign oil dependence. The 2004 Department of Energy budget for all types of renewable energy totaled $1.3 billion, increasing just 0.1 percent from 2002 to 2004, while lagging the entire Department of Energy budget, which increased 5.9 percent. Even if ANWR were fully exploited, proven reserves total about 7.7 billion barrels of recoverable oil, enough to supply the Nation for just over a year. Although the *National Energy Policy* sets forth a range of conservation and alternative technologies, no meaningful fiscal policy steps have been taken to bring them to the fore.

domestic production is declining at a rate of 1.5 million barrels per day

Dwindling Global Supply

In 1956, geophysicist M. King Hubbert pioneered a model for petroleum extraction known as Hubbert's curve. It predicts that early in the life of an oilfield, production will increase rapidly due to infrastructure growth. The field will reach a point where production peaks and, barring new discoveries, no addition of technology will yield further gains. Thus, "Hubbert's peak" marks the onset of decline, a trend that accelerates as the cost of further extraction approaches the commercial value of each barrel pumped.

In many "easy" oil instances, the oil is actually pressurized coming out of the ground, reminiscent of the gushers seen in Hollywood movies. In an oilfield with this so-called high lift, the price of oil at the wellhead is less than $5.00. Post-wellhead costs are added through royalties, transportation, refining, delivery, and profit. As more oil is extracted, it becomes necessary to pump the oil from the ground; thus the wellhead price rises through the life of an oilfield. Eventually, the cost of extracting the next barrel of oil exceeds the oil's market value, and the well is capped.

Hubbert based his model on oil production within the lower 48 states, the region where oil was first commercially exploited on a large scale. He predicted that within a given oilfield, the peak in new *discoveries* would be followed within a few years by a peak in *production*, and then decline. He also postulated that peak production would occur when approximately half of the total reserves in a given area were depleted. Hubbert forecast in 1956 that lower–48 oil production would reach its maximum about 1970, which has proved true.

The United Kingdom's portion of the North Sea oilfields reveals a similar pattern. These fields reached their Hubbert's peak in 1999 and are now in decline, with production expected to cease after 2020.

Hubbert's concepts might be applied to global oil production as well. Prior to 2000, the majority of studies projected an ultimate recoverable supply of 2 trillion barrels of oil. In 2000, the U.S. Geological Survey (USGS) forecast a 50 percent increase in estimated world reserves to 3.003 trillion barrels. As soon as it was published, the study came under fire for what many considered optimistic assumptions. Discounting the USGS results, there has historically been broad agreement that the world's ultimate oil supply equaled approximately 2 trillion barrels. In one recent study, the average estimate of 76 studies works out to be 1,930 billion barrels, of which 920 billion (48 percent) have been consumed.

Today, the oil supply prediction camp is divided among the optimists, represented by organizations such as the USGS, and pessimists such as the Association for the Study of Peak Oil and Gas. The optimists agree that Hubbert's peak is coming but will not occur until 2021 at the earliest and 2112 at the latest, with 2037 as the median date. The pessimists believe the USGS study was based on speculative methodology and the peak is as close as 2007. The pessimists cite the growing gap between discovery and production. They say that if the USGS predictions are accurate, the annual discovery rate between 1995 and 2025 needs to average 21.6 billion new barrels. New global oil discoveries over the last 12 years have averaged 7.4 billion barrels annually, far below both USGS predictions and global consumption, which averaged 28 billion barrels a year for the same period. Since 1980, more oil has been extracted than has been offset by new discoveries.

America's Fragile Oil Lifeline

Most of the world's so-called easy oil has already been discovered or extracted, leaving the bulk of the undiscovered or unexploited oil in deep water, or other isolated locales far from transportation infrastructure and markets. The most promising possibilities for discovery are in the Caspian Basin and Russia, areas torn by strife and instability. A prediction of future oil production patterns (produced by the pessimists) forecasts a peak in global oil production in approximately 2007.

Since the USGS report of 2000, most studies have distanced themselves from its numbers. A summer 2004 report by BP–AMOCO estimated the remaining oil supply at 1,147.8 barrels,[2] a figure in close agreement with the estimate of the U.S. Energy Information Agency, 1,266 billion barrels.[3] These studies buttress the view that we are approaching worldwide peak oil production.

Although the pessimists offer a convincing argument presaging a peak in global oil production, what if they are wrong? What if technology and discovery can delay it far into the 21st century? Assuming the oil is available somewhere on the globe, can we reliably deliver it here? During 2003, the United States averaged imports of 12.2 million barrels per day, representing 62 percent of its total oil demand. Much of this imported oil comes from politically volatile parts of the world.

Saudi Arabia has the world's largest oil reserve, estimated at 250 billion barrels (Gb).[4] Peak Saudi production will not occur until 2020; thus Saudi Arabia will remain "the indispensable nation of oil." Saudi Arabia is ruled as a feudal monarchy, with absolute authority held by the descendants of Abd al-Aziz ibn Saud, who rose to power in 1932. Its vast oil wealth masks a nation with pressing demographic and political problems. More than half of all Saudis are under 18 years of age. This group is plagued by limited educational opportunities and high unemployment, factors that have made Saudi Arabia fertile ground for religious extremism. The official state religion is Wahhabism, an inimical form of Islam that is the philosophical antecedent for Osama bin Laden and his followers. The government has taken steps to eliminate terrorist funding and curtail al Qaeda recruitment within the kingdom; however, the long-term prognosis for success is not clear. In the meantime, Saudi Arabia remains *the* linchpin of U.S. energy security even though it is beset by political tension, internal dissent, and a looming demographic crisis.

Mexico is tied to the U.S. economy through the North American Free Trade Agreement (NAFTA), which has been a mixed blessing for Mexicans. Although elimination of all trade barriers led to a flood of foreign investment and industrialization during the 1990s, many of these jobs have since moved to even lower wage countries. NAFTA was championed as a solution for emigration problems, but Mexicans continue to migrate north in search of employment and higher wages. A legacy of political corruption, high unemployment, and the corrosive effects of a burgeoning narcoeconomy represent great challenges.

Mexico has made no major oil discovery since 1980. The pessimists estimate that Mexico has approximately 22 billion barrels (Gb) of oil remaining. Production will peak around 2015. Although Mexico is currently a net oil exporter, growing domestic consumption will exceed production by 2010, closing the Mexican spigot as a source of oil for the United States.

The Venezuelan oil industry was born in 1866, only 7 years after production began in the United States. Venezuela used this leadership in 1960 to midwife the birth of the Organization of Petroleum Exporting Countries (OPEC), going on to nationalize Venezuelan resources in 1976.[5] The country's history has been characterized by revolution, counterrevolution, and dictatorship. The latest chapter began with the election of Hugo Chávez in 1998. Although Chávez came to power as a populist reformer, an 18 percent contraction in the economy and his dictatorial practices triggered a national work stoppage in 2002, slowing oil production to a trickle.

Venezuela possesses about 50 Gb of conventional oil reserves, with exploitation having peaked around 2003. Venezuela also has a vast reserve of heavier oils, estimated as high as 1,200 Gb, which equals the entire conventional reserve remaining worldwide. The greatest barrier to exploiting this resource has been the low recovery rate of useable oil (10–15 percent) and the high front-end cost. In the early 1990s, the government set the exploitation tax at 1 percent in an effort to draw the massive foreign investment required to bring heavy oils on-line. In October 2004, Chávez raised these tax rates to 16 percent to correct "foreign domination mechanisms."[6] Low internal consumption will place Venezuela at the forefront as a U.S. energy source for decades. But access will hinge on the policies of Hugo Chávez and his successors.

Nigeria was a British colony until it gained independence in 1960. Between 1966 and 1999, it was ruled by a series of military governments and torn by ethnic civil war and religious strife. Nearly 2 million perished from violence, hunger, and disease. Nigeria today is ruled by a democratically elected government, which has a well-deserved reputation for corruption. "For decades, powerful elites in the capital of Abuja have monopolized the allocation of petroleum revenues, providing relatively little to the ethnic minorities of the Niger Delta region, where most of the oil is buried. These minorities have grown increasingly dissatisfied and have launched armed attacks on oil facilities, causing a sharp drop in exports."[7] Nigeria retains substantial oil resources, estimated by the pessimists at 40 Gb, with a production peak forecast for approximately 2009.[8]

During 2003, the worldwide oil industry produced an average of 68 million barrels per day, with every producer but Saudi Arabia operating at maximum capacity. Saudi excess oil production capacity currently stands at less than 1 million barrels per day, a 0.7 percent world production capacity cushion. The continued viability of the U.S. energy lifeline hangs on political and economic stability in nations such as Saudi Arabia, Venezuela, and Nigeria. Interruption of oil production in any of the teetering countries described here would trigger immediate price rises and economic dislocation. The simultaneous loss of several oil-producing nations due to boycott, sabotage, or war would be an economic catastrophe.

The Military Challenge

Military operations to ensure energy access and price stability have added an invisible subsidy to the true cost of imported oil. From 1991 to 2004, the average cost of a gallon of unleaded gas at a U.S. pump was as high as $2.28. When the $2.2 trillion cost of 9/11 and all Middle East/Central Asia operations since *Desert Shield* are factored into the 1.71 trillion gallons American consumers have used since 1991, the cost at the pump rises to $3.56 per gallon (see table). The current energy strategy understates these costs of seeking energy security through military action. The invisible hand of market forces, which should trigger oil conservation at a price of $3.56 per gallon, has been disrupted by the externalized military cost.

Future military efforts to secure the oil supply pose tremendous challenges due to the number of potential crisis areas. Besides the nations already mentioned, the bulk of the world's oil reserve is concentrated in the Middle East and Central Asia. In order of proven resources, these countries are Iraq, Kuwait, United Arab Emirates, Iran, Russia, and the nations surrounding the Caspian Basin. This region, especially the Arab nations, has been referred to as the "gap," an area characterized by poverty, disorder, and social upheaval.

The Middle East is faced with explosive population growth. By 2020 this area's population is projected to pass 800 million, a 30 percent increase. This surge will place huge strains on already struggling governments and provide

Costs of Middle East Operations and 9/11, 1991–2004

Total cost of Gulf War I	**$300B**
Annual peacetime force structure cost for units tasked for the Middle East ($60B x 13 years)	$780B
Annual cost of no-fly-zone enforcement and deployed Army forces in Kuwait, 1991–2002 ($15.3B x 11 years)	$168.3B
Economic costs to the U.S. economy of the 9/11 attacks	$585.2B
Cost of operations in Iraq (based on substantial withdrawal in 2008)	$308.9B
Cost of Operation *Enduring Freedom* and follow-on operations in Afghanistan ($1.6B/month, 2002 + $1.1B/month, 2003–2004)	$45.6B
Uzbekistan aid and airfield access payments, 2002	$.320B
Uzbekistan aid and airfield access payments, 2003–2004	$.357B
Foreign aid to Pakistan, 2002	$.696B
Foreign aid to Pakistan, 2003–2004	$1.2B
Kyrgyzstan foreign aid and airfield access	$.500B
Foreign aid to Tajikistan	$.563B
Foreign aid to Turkmenistan	$.274B
Total U.S. gasoline consumption, 1991–2004 (gallons)	**1,716.96B**
Hidden fuel price subsidy at the pump (cost of Middle East operations/total consumption)	**$1.276/gal**

Sources: Grant T. Hammond, "Myths of the Gulf War," *Aerospace Power Journal* 16 (November 2004), available at <http://www.airpower.maxwell.af.mil/airchronicles/apj/apj98/fal98/hammondtxt.htm>; Amory B. Lovins, "U.S. Energy Security: Factsheet," *Alaska Building Science News* 9, no. 1 (Fall 2003), available at <http://www.north-rthn.org/Newsletters/ABSN-Fall-03.pdf>; U.S. House of Representatives Budget Committee, Democratic Caucus, "The Cost of War and Reconstruction in Iraq: An Update," 108th Congress, 2003; Robert Looney, "Economic Costs to the United States Stemming from the 9/11 Attacks," *Strategic Insight* (Monterey, CA: Naval Postgraduate School, August 2002); Dennis Ryan, "Comptroller Tallies Operation *Iraqi Freedom* Cost," *Pentagram*, November 16, 2004, available at <http://www.dcmilitary.com/army/pentagram/8_15/national_news/22760-1.html>; Lutz Kleveman, *The New Great Game—Blood and Oil in Central Asia* (New York: Atlantic Monthly Press, 2003), 173, 186, 245; U.S. Department of State, "Background Note: Pakistan," "Background Note: Uzbekistan," "U.S. Assistance to Tajikistan Fact Sheet," "U.S. Assistance to Turkmenistan Fact Sheet," available at <http://www.state.gov/r/pa>; U.S. Department of Transportation, "Corporate Average Fuel Economy Standards," available at <http://www.nhtsa.dot.gov/cars/rules/rulings/CAFE/EnvAssessed/Index.html#_Toc26683550>.


Khawr Al Amaya Oil Terminal in the Arabian Gulf

Fleet Combat Camera, Atlantic (Aaron Ansarov)

a ready source of recruits for grievance organizations such as al Qaeda, for whom dissatisfied young males have been described as a center of gravity.

The last oil frontier lies around the Caspian Sea. Although previous estimates placed its oil resources as high as 110 Gb, further exploration has lowered expectations to 17–33 Gb, well below those of Iraq or Kuwait, but still substantial. Over the long term, natural gas may prove the most valuable resource there.[9] Four of the six Caspian Sea states are former Soviet republics and are eager to free themselves of all vestiges of Russian domination. Only two of the four, Azerbaijan and Kazakhstan, have significant oil resources. Turkmenistan and Uzbekistan can only hope to enjoy economic benefits through pipeline transit fees. All existing and proposed Caspian pipelines pass through some of the world's most war-torn real estate, including a proposed pipeline across Afghanistan.

The bulk of demand during the next decade will come from Asia. "In 1993, after decades of self-sufficiency, Chinese domestic oil production could no longer satisfy demand, which had shot up because of the country's extraordinary economic growth. Since then, China has imported more oil every year, from 6.4 percent of its consumption in 1993, to 31 percent in 2002, to a projected 60 percent by 2020."[10] The Asia-Pacific region's dependence on Middle East oil may exceed 90 percent by 2010.

Military and economic efforts to expand oil access in the Caspian Basin, like our actions over the past 60 years in the Persian Gulf, could bring the United States into conflict with energy-hungry regional powers such as China and India. Played out far from traditional U.S. supply lines, clashes would minimize our advantages in naval and air power and depend largely on ground forces and asymmetric warfare.

The world energy delivery system is incredibly fragile. This vulnerability creates a vast universe of options for hostile nations, terrorists, and antiglobalists to create mischief by sabotage, destruction of key facilities, or interdicting transportation bottlenecks. The giant Ras Tanura loading facility in Saudi Arabia processes half of all Saudi production and thus a tenth of all global production each day. An attack on it could take half of Saudi oil off the market for at least 6 months, triggering a worldwide economic catastrophe. "Such an attack would be more economically damaging than a dirty nuclear bomb set off in midtown Manhattan or across from the White House in Lafayette Square."[11]

Energy Consumption Patterns

Petroleum provides nearly 40 percent of all energy used in the United States, a share that is forecast to rise over the next 20 years. Increasing reliance on oil coupled with declining domestic production will trigger increasing demand for foreign oil. Today, imports comprise 62 percent of total petroleum consumption, predicted to rise to 70 percent by 2025.

The main users of petroleum are the transportation and industrial sectors. Oil provides 95 percent of the energy for transportation and 20 percent for the industrial sector. Recognition that world oil supplies have reached Hubbert's peak will have major implications in the industrial world. Worldwide consumption is rising 3 percent annually, with the greatest growth in China. The oil energy industry generates annual revenues of $2.1 trillion. Most transportation technologies have useful lifetimes of 15 years or more. Transition to alternative technologies could thus render part or all of this investment worthless and will not be undertaken until the economic arguments are unimpeachable. Although rising prices and sagging supplies will eventually produce clear incentives to conserve and deploy alternative energy sources, in many cases these signals may not arrive until very late in the supply collapse, minimizing time for classic economic incentives to act.

The first barrier to solving this problem lies in public and policymaker perceptions. Oil price shocks and fluctuations have been common since 1974, but each time the warnings proved false. For that reason alone, it may prove difficult to convince the public and policymakers that an era of permanently limited oil supplies has arrived. Predicting the shape of the post-peak supply is also hard. Although Hubbert's theory depicted a symmetrical curve of growing and then shrinking production, the actual production pattern is highly dependent on the geology of individual oil fields and the level of investment in production technology. Further, some portion of the production shortfall may be offset by conservation and increased use of other fuels such as natural gas, oil sands, coal gasification, and synthetic oil. During World War II, German engineers discovered that synthetic oils manufactured from coal become viable substitutes at a cost of around $60 per barrel. The shape of the peak and the impact of "swing" fuels such as synthetic oil are difficult to predict. However, the key fact to remember is that none of these replacement technologies will happen overnight; rather, they will be the result of deliberate policy and investment decisions with lead times that may approach a decade.

Before discussing what will work, let us remind ourselves of what will not work. Developing additional resources offshore or in the Arctic will not provide the long-term solution. Oil economics have supplied great incentives to discover more sources over the past decade. Despite these incentives and ever more sophisticated technology, new discoveries are not keeping pace with consumption. Alaskan production at Prudhoe Bay peaked in 1988. The much-touted ANWR is estimated to contain about 7.7 billion barrels of recoverable oil, enough to supply the United States just over a year. Although tar sands and heavy oil hold promise, their economics and energy balance are daunting at best. In sum, trying to drill our way out of this crisis will not address the real problem, which is soaring demand and the danger of military conflict over shrinking resources.

the continued viability of the U.S. energy lifeline hangs on political and economic stability in nations such as Saudi Arabia, Venezuela, and Nigeria

Phase I: Conservation

A national energy plan along the lines of the historic Manhattan Project is needed now. America faces a strategic imperative to decisively deploy a range of solutions, both interim and permanent, to address energy security. Such an effort might consist of two phases: conservation and the energy power shift.

The U.S. fuel savings record is not impressive. The aftermath of the 1973–1974 oil embargo saw the establishment of Government-mandated automotive mileage standards. By 1985, the average fuel economy of the U.S. fleet had risen from 12.9 to 27 miles per gallon (MPG) to 27 MPG. However, since 1985, these gains have remained largely static as economy targets remained unchanged. Improved fuel economy has been thwarted by the policy decision to set separate lower economy standards for trucks. The growing percentage of lower-economy trucks has led to a decline in the overall economy of the automotive fleet.

Even at $2.25 per gallon, there are few incentives for Americans to conserve. At this price level, the annual penalty of driving a gas-guzzling sports utility vehicle (SUV) instead of a more economical four-door car is about $500 per year. The dearth of economic incentives coupled with gas prices considerably lower than the highly taxed Europeans pay means that oil consumption per dollar of GDP is now more than 40 percent higher than in Germany and France.

Hybrid automobiles. Hybrids are a revolution in automotive design that combines a conventional gas engine with an electric motor. There are three hybrid cars and three hybrid trucks among the 2005 model year offerings. The three cars, all from Japanese automakers, average over 50 MPG and are mature designs of considerable research and engineering. Replacing every vehicle with a high mileage hybrid would cut consumption in half, nearly eliminating the need for imported oil. Improving the average fuel efficiency of the entire car fleet by just 5.3 miles per gallon could displace all Persian Gulf imports.[12]

Ethanol-based fuels. Expanding production of ethanol alcohol offers a means of replacing imported oil with a domestic agricultural product. All current automobiles can operate on fuels up to 15 percent ethanol. Flexible fuel vehicles (FFV) are designed to operate on mixed fuels up to E85, a mixture of 15 percent gasoline and 85 percent ethanol. Over 4 million automobiles on the road are factory-equipped to use E85 fuels. Retrofit to FFV capability is a straightforward process that costs about $50 per vehicle.

Ethanol-augmented fuels are available mainly in the Midwest, where ethanol is made using a corn-based fermentation process. Today, 81 plants around the country are manufacturing corn ethanol with a capacity of 3.4 billion gallons per year; 15 plants under construction will add a further 670 million gallons per year. Corn ethanol critics observe that it takes more energy (in the form of fertilizers, farm machinery, processing into ethanol, and so forth) to grow the corn and distill the ethanol than is available in the final product. The corn ethanol production chain is dominated by corporate producers who have mobilized substantial political support for a corn ethanol tax subsidy regime of $1.4 billion per year.

Corn is a poor choice for ethanol feedstock since it is the most irrigation- and fertilizer-intensive crop grown in the United States, and corn used for ethanol drives cattle feed prices higher, creating hidden costs at the grocery store. Although a nascent corn ethanol industry has developed, future expansion should be discouraged through a removal of the tax regime. Unsubsidized corn ethanol actually costs $2.24 per gallon to produce, making it uneconomical except in times of very high oil prices.[13]

The biorefinery and cellulosic ethanol. Instead of valuable corn, the biorefinery produces ethanol using the starches and cellulose present in agricultural waste and byproducts such as corn stalks, rice straw, paper mill waste, recycled urban waste, and dedicated woody stemmed crops.[14] Many of these sources of cellulosic ethanol are considered negative-cost feed stocks, meaning they have no food value and farmers must pay for their disposal. This gives cellulosic ethanol a much higher net energy balance than corn-based ethanol. Studies at candidate biorefinery sites in Indiana and Nebraska found that collocating ethanol biorefineries with existing power plants would allow production for $1.05/gallon to $1.60/gallon depending on the biomass selected. Cellulosic ethanol offers great promise for rural areas that have seen considerable depopulation due to modern farming methods.

One cellulose ethanol plant would enhance energy security by replacing crude oil imports of 2.4 to 2.9 million barrels per year; increase farm income by $25 million per year by creating economic value for residues that currently have little to no value or are simply viewed as waste; create economic development by creating over 1,000 new jobs during peak construction, and almost 200 new permanent jobs and about 450 spin-off jobs.[15]

Biorefineries also hold great promise for urban areas. A typical large city has a substantial surplus of yard waste and wood debris, products that can no longer be deposited in landfills. New York and Philadelphia pay $150 per ton to dispose of municipal solid waste. Creating a simple urban wood recycling routine of household recycling bins would ensure a steady biomass supply and strengthen the economics of urban biorefineries through proximity to markets. Building an urban biorefinery in the hundred largest metropolitan areas could produce 7 billion gallons of ethanol a year, offsetting imported oil by 5 percent while helping solve urban waste problems.

recognition that world oil supplies have reached Hubbert's peak will have major implications in the industrial world

The biorefinery is not a fanciful dream. In 1975, Brazil initiated a domestic ethanol program based on sugar cane waste. Over its 30-year life, the ethanol industry has produced $50 billion worth of ethanol while supporting 700,000 Brazilian jobs. Electricity cogenerated at biorefineries provides 9 percent of national requirements. Ethanol supports a fourth of domestic petroleum demand and can be priced more cheaply than gasoline.[16] According to testimony in the Senate, sufficient cellulosic biomass is available in the United States *right now* to displace up to 10 percent of today's oil imports.[17]

The first step of implementation will be to emplace economic incentives to conserve fuel. New hybrid vehicles enjoy a tax credit of $1,500, which is due to expire in 2006. This program must be expanded, and although taxation and incentives are anathema to many politicians, a cost-neutral regime that taxes production and purchase of low economy models and rebates for purchase of hybrids and FFVs must be imposed.

The second step is to resume increasing the CAFE fleet fuel economy requirement. The requirement has remained static at 27.5 MPG since 1985, while light trucks and SUVs have essentially received a free ticket. The CAFE fuel economy requirement must resume its move upward in a fashion that produces sound public policy outcomes without exceeding the engineering capability of the automotive industry. The SUV and light truck requirement, set at 20.7 MPG, needs a realistic economic target that balances the needs of the consumer with national energy security.

Step three institutes a crash program to build cellulosic ethanol facilities. Placement studies for ethanol plants designed to consume a mixture of agricultural wastes and grain have estimated a construction cost of $27 million to build a facility capable of producing up to 15 million gallons of ethanol per year. At a proposed site in North Dakota, suitable agricultural waste and inconsumable grain are already available to produce 12.5 million gallons of ethanol a year at no cost. Many potential sites could solve *existing* waste disposal problems, exploiting negative-cost biomass to turn waste into treasure. National Renewable

Director of Penn State's Energy Institute displays a flow reactor that tests the thermal stability of a coal-blended jet fuel that has been in development over the past 15 years

AP/Wide World Photo (Pat Little)

Energy Lab studies show that an investment of $31 billion would build 225 plants capable of producing enough ethanol to replace over 10 percent of gasoline consumption.

Farmers need incentives to grow energy crops such as switchgrass, a native plant that does not require fertilizer or irrigation. It is estimated that 15 percent of the North American continent consists of land that is unsuitable for food farming but workable for switchgrass cultivation. "If all that land was planted with switchgrass, we could replace every single gallon of gas consumed in the United States with ethanol."[18] Farm policies that encourage energy crop plantations are crucial for creating a firm supply base for cellulosic ethanol.

Expanded use of hybrid cars and biorefineries provides an interim strategy that enhances energy security while smoothing the transition to the next phase of an energy Manhattan Project, the "Energy Power Shift,"[19] a move to emerging transportation technologies that offer permanent energy security.

unsubsidized corn ethanol costs $2.24 per gallon to produce, making it uneconomical except in times of very high oil prices

Phase II: The Energy Power Shift

Although the "hydrogen economy" is widely cited in political discourse, its practicality is doubtful. Proponents cite the vast renewable energy from wind, solar, and biomass sources. Massive wind farms, occupying merely a portion of the Dakotas, could theoretically produce sufficient hydrogen through electrolysis to power all domestic transportation needs. Although it is possible to produce hydrogen in this fashion, storing, transporting, and distributing it to markets is problematic. Waiting to transition to the hydrogen economy ignores proven and inexpensive *good* technology in favor of unproven and costly *perfect* technology. Instead of hydrogen, phase II should focus on plug-in hybrid vehicles and optimizing the biorefinery concept.

Plug-in hybrid electric vehicles (PHEVs). The next evolutionary step from the Toyota Prius, PHEVs use the same principle as today's hybrid with the addition of a larger battery and a 120 volt electric wall plug. The PHEV charges its battery at night from the wall socket or even while parked at work. The enlarged battery is capable of driving the PHEV entirely electrically below 35 miles per hour (mph) for about 60 miles, well within the typical commuting range. When the PHEV is driven faster than 35 mph or beyond 60 miles, the conventional motor picks up the load. Fully operational prototypes have already been built using modified Toyota Priuses. These existing PHEVs average up to 180 MPG in typical commuter profiles since most driving is done in electric-only mode. The energy-per-mile cost of electricity is a third the cost of gasoline. PHEVs transfer a large portion of the transportation energy bill to the electric grid, whose capacity is underused at night and can grow through the addition of existing and proven renewable energy technologies such as wind, solar, and distributed fuel cells.

Oil refinery plant in Basra, Iraq

55th Signal Company (Christopher J. Crawford)

Improved biorefinery. The centerpiece of the second pillar of phase II, improved biorefinery, is the thermal conversion process (TCP), by which the geological conditions that produce oil are recreated. A technology demonstration plant in Carthage, Missouri, is producing 500 barrels of oil a day using turkey manure, bones, paper products, wood, municipal waste, and sewage. The TCP produces usable oil at a cost of 40 cents per gallon using landfill waste as a feedstock.

Although the steps outlined in phase I will offer breathing space against the demise of the oil-based economy, rising demand and falling production suggest that a transition to phase II must be defined, capitalized, and executed with rigor. The 2005 Department of Energy budget earmarks $2.5 billion for all categories of energy research. Given that the United States has spent $2.2 trillion over the past 14 years seeking energy security through military action, $50 billion spent to accelerate the arrival of PHEVs, TCP biorefineries, or other as-yet-undefined technology would seem a policy decision ranking with Thomas Jefferson's Louisiana Purchase.

An ancillary bonus—clean air. Environmentalists have championed many of the above ideas for years but have been largely ignored or grudgingly placated with half-measures. Until now, economic considerations have trumped many of the environmentalists' arguments as cheap gas and lack of government commitment knocked the props out from under the green platform. The Manhattan Project for energy would provide an ideal convergence of interests, bringing the economist, diplomat, soldier, and environmentalist under the same tent. In addition to girding energy security, PHEVs and TCP biorefineries offer dramatic improvements in the pollution impact of the transportation sector by either eliminating noxious byproducts entirely or transferring to less polluting energy sources.

the current world energy situation poses a national threat unparalleled in 225 years

America's Strategic Imperative

The current world energy situation poses a national threat unparalleled in 225 years. The economy, particularly the transportation component, has become heavily dependent on foreign oil. Concurrent with rising demand are indications that world production may soon peak, followed by permanent decline and shortage. Moreover, most of the remaining oil is concentrated in distant, politically hostile locations, inviting interdiction by enemies.

Over the last 60 years, policymakers have repeatedly applied diplomatic and military triage to the problem of national energy security while generally ignoring the economic prospects for a solution. Today, the Nation is engaged in a global war on terror throughout the same resource-rich area on which the safety of its economy hinges. Economic stagnation or catastrophe lurk close at hand, to be triggered by another embargo, collapse of the Saudi monarchy, or civil disorder in any of a dozen nations. Barring these events, rising world demand and falling production could place the United States in direct military competition with equally determined nations. It is doubtful that any military, even that of a global hegemon, could secure an oil lifeline indefinitely. Failing to take urgent economic steps now will necessitate more painful economic steps later and likely require protracted military action.

Meeting this dilemma with a technical solution plays on America's greatest strengths, those of the inventor and the innovator. Rapid execution of a two-phase Manhattan Project for energy will provide near-term relief measures while laying the foundation for the long-term establishment of an "Energy Power Shift" economy. Reduced dependence on imported oil would also allow the Nation to pursue a more pragmatic foreign policy, freed of the necessity to engage in all episodes of Middle East or OPEC history. This strategy denies al Qaeda and its allies a key argument in their war against the United States; reducing the strategic importance of the Middle East will obviate the need for "us" to be "there" and diminish the cultural friction between Muslims and the West. Absent the plausible charge that the U.S. role in the Middle East is motivated solely by oil, U.S. efforts to nurture democracy, and local perception of those efforts, could result in a new era of good will. Although this problem is daunting, it is not unsolvable; instead, it demands prompt and certain action to ensure an energy-rich and peaceful future. **JFQ**

When you are drifting down the stream of Niagara, it may easily happen that from time to time you run into a reach of quite smooth water, or that a bend in the river or a change in the wind may make the roar of the falls seem far more distant. But your hazard and your preoccupation are in no way affected thereby.[20]

—Winston Churchill

NOTES

[1] National Energy Policy Development Group, *National Energy Policy*, May 2001, available at <www.whitehouse.gov/energy/>.

[2] BP–AMOCO, BP Statistical Review of World Energy, June 2004, accessed at <www.bp.com>.

[3] Guy Caruso, *U.S. Oil Markets and the Middle East* (Washington, DC: U.S. Department of Energy, October 20, 2004).

[4] "Country Assessment: Saudi Arabia," *Association for the Study of Peak Oil Newsletter* 21 (Cork, Ireland: 2002).

[5] "Country Assessment: Venezuela," *Association for the Study of Peak Oil Newsletter* 22 (Cork, Ireland: 2002).

[6] Iain Bruce, "Venezuela Raises Oil Drilling Tax," *BBC News World Edition*, October 11, 2004.

[7] Michael T. Klare, "Growing Militarization of Our Oil Dependence," *The Boston Globe*, October 12, 2004.

[8] "Country Assessment: Nigeria," *Association for the Study of Peak Oil Newsletter* (Cork, Ireland: 2003).

[9] U.S. Department of Energy, Energy Information Agency, *Country Analysis Briefs: Caspian Sea Region* (Washington, DC: Department of Energy, June 2004).

[10] Institute for the Analysis of Global Security, *Energy Security in East Asia*, August 13, 2004, available at <www.iags.org/n0813042.htm>.

[11] Gal Luft and Anne Korin, "Terror's Next Target," *The Journal of International Security Affairs* (December 2003), available at <www.iags.org/n0111041.htm>.

[12] Rocky Mountain Institute, *Fuel Supplies and Security* (Snowmass, CO: Rocky Mountain Institute, 2004), available at <www.rmi.org/sitepages/pid405.php>.

[13] David Pimentel, "Ethanol Fuels: Energy Balance, Economics, and Environmental Impacts Are Negative," *Natural Resources Research* 2 (June 2003).

[14] BC International Corporation, *Ethanol From Biomass Process*, November 13, 2004, available at <www.bcintlcorp.com/technology.htm>.

[15] U.S. Senate, Proceedings and Debates of the 108th Congress, 2d Session, September 15, 2004.

[16] Amory B. Lovins et al., *Winning the Oil Endgame* (Aspen, CO: Rocky Mountain Institute, 2005).

[17] U.S. Senate.

[18] Sam Jaffe, "Independence Way," *The Washington Monthly* (July/August 2004),18.

[19] Barry J. Hanson, *Energy Power Shift: Benefiting from Today's New Technologies* (Maple, WI: Lakota Scientific Press, 2004).

[20] William Manchester, *The Last Lion: Winston Spencer Churchill Alone: 1932–1940* (New York: Little, Brown and Co., 1988), 198.

Tanker truck being loaded with ethanol at Golden Grain Energy plant, which generates renewable fuels

AP/Wide World Photo (Charlie Neibergall)