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LETTER OF INTRODUCTION

JUNE 8, 2006.

DEAR COLLEAGUE: The Committee on Foreign Relations is continuing to hold a series of hearings examining the geopolitical consequences of global energy imbalances and U.S. dependence on energy imports. Given the growing importance of energy security in our foreign policy today and the prominence of energy in our ongoing policy debates, I believe it is important that these analyses be made available to the entire Senate.

The current United States energy portfolio, and in particular our dependence on foreign oil, has widespread and dramatic impacts on our national security. On March 13, 2006, in a speech at the Brookings Institution, I outlined the scope of the challenge before us, including myriad threats to our national security and economic prosperity. Over the past few months, the Committee held several hearings focusing on these threats caused by our current dependence on oil.

The Honorable Alan Greenspan, former Chairman of the Federal Reserve, testified on the subject of "Oil Dependence and Economic Risk" at a hearing on June 7, 2006, including the vulnerabilities of the current global oil market and the need for reducing the dominance of oil in our energy portfolio.

On May 16, 2006, the Committee examined strategies to reduce our oil dependence at a hearing on "Energy Security and Oil Dependence." Mr. Vinod Khosla, Partner of Khosla Associates, and Mr. Jason Grumet, Executive Director of the National Commission on Energy Policy offered testimony.

A hearing on March 30, 2006, entitled "Hidden Costs of Oil" focused on understanding the full range of economic costs associated with U.S. oil dependence. Testimony was heard from Mr. Milton Copulos, President of the National Defense Council Foundation, Dr. Hillard Huntington, Executive Director of the Energy Modeling Forum at Stanford University, and Dr. Gary Yohe, John E. Andrus Professor of Economics at Wesleyan University.

On November 16, 2005, The Honorable James Schlesinger, former Secretary of Defense, Secretary of Energy, and Director of Central Intelligence, and The Honorable R. James Woolsey, former Director of Central Intelligence, gave testimony on the severity of the challenges posed by energy security at a hearing entitled "High Costs of Crude: The New Currency of Foreign Policy."

I believe that the information contained in this print can be helpful in preparing Members for subsequent Senate debate on this issue of vital national security interest.

Sincerely,

RICHARD G. LUGAR, *Chairman,*
Senate Committee on Foreign Relations.

U.S. Senate Foreign Relations Committee Chairman, Richard G. Lugar, addressed the Brookings Institution, March 13, 2006, on "U.S. Energy Security—A New Realism."

It is a privilege to deliver the inaugural speech for the Brookings Institution's 90th Anniversary Leadership Forum series. I have had the opportunity to come here to share my thoughts on a number of national security issues over the years, and your reception has always been generous. I appreciate very much receiving the invitation to speak from my good friend, Strobe Talbott, who has been a source of sound counsel for many years and who continues to provide outstanding national and international leadership.

Last August, I represented President Bush on a diplomatic mission to North Africa. The President asked me to go to Algeria and Morocco to facilitate the release of the longest-held prisoners of war in the world—404 Moroccan soldiers, some of whom had been held since the 1970s by the Polisario Front operating out of Algeria. American diplomats had discussed their potential release, and General Jim Jones, Supreme Allied Commander Europe, had offered to transport the POWS home to their families in Morocco. After this humanitarian mission had been fulfilled, I had the opportunity, with the Administration's blessing, to continue on to Libya for meetings with Libyan officials, including Muammar Qaddafi.

While staying overnight in the Corinthia Hotel in Tripoli, overlooking the Mediterranean, I came face to face with a microcosm of the new reality of global economic life. It was impossible to walk around the hotel without meeting someone who was hoping to tap into Libya's oil reserves. The hotel was populated with representatives from China, India, and Western oil companies who were in Libya to stake out drilling or refining options for every pool of oil that the government might make available. The world had come to the Corinthia Hotel to compete for the energy opportunities that were expected to develop with Libya's hopeful return to the international mainstream.

I relate this anecdote to underscore how rapidly the world is changing due to the expansion of energy demand. These conclaves of modern day oil prospectors can be found wherever there are proven energy supplies and a government willing to bargain. Indeed, my delegation also saw evidence of this in natural gas-rich Algeria. The Chinese and Indians, with one third of the world's people between them, know that their economic future is directly tied to finding sufficient energy resources to sustain their rapid economic growth. They are negotiating with anyone willing to sell them an energy lifeline.

THE SHIFTING BALANCE OF REALISM

The gasoline price spikes following the Katrina and Rita hurricanes underscored for Americans the tenuousness of short-term energy supplies. But, as yet, there is not a full appreciation of our economic vulnerability or the competition that is already occurring throughout the world.

In a remarkable moment during the State of the Union Address, President Bush caught the attention of the nation with five words: "America is addicted to oil." Those five words probably generated more media commentary than all the rest of his remarks from that evening combined. I had an opportunity soon after the speech to talk to the President about energy, and he admitted that he had not anticipated the impact of that statement or that some commentators would find it incongruous. I believe he is genuine in wanting to devote more focus to pursuing alternative energy sources. But his Texas roots, his administration's high-profile advocacy of opening up the Arctic National Wildlife Refuge to drilling, and other associations with the oil industry have created long-standing public impressions that the President is an oil-man who believes in the oil economy.

Though not hostile to alternative energy sources, the Bush administration clearly downplayed their significance during the early part of his Presidency. Vice President Cheney, who oversaw Bush administration energy policy, stated on April 30, 2001, "Years down the road, alternative fuels may become a great deal more plentiful than they are today. But we are not yet in any position to stake our economy and our way of life on that possibility. For now, we must take the facts as they are. Whatever our hopes for developing alternative sources and for conserving energy—and that's part of our plan—the reality is that fossil fuels provide virtually 100 percent of our transportation needs and an overwhelming share of our electricity requirements. For years down the road, this will continue to be true."

For decades, the energy debate in this country has pitted so-called pro-oil realists against idealistic advocates of alternative energy. The pro-oil commentators have attempted to discredit alternatives by saying they make up a tiny share of energy consumed and that dependence on oil is a choice of the marketplace. They assert that our government can and should do little to change this. They have implied that those who have bemoaned oil dependency do not understand that every energy alternative comes with its own problems and limitations. Lee Raymond, the former CEO of Exxon offered an example of this line of reasoning in 2005: "There are many alternative forms of energy that people talk about that may be interesting. But they are not consequential on the scale that will be needed, and they may never have a significant impact on the energy balance. To the extent that people focus too much on that—for example, on solar or wind . . .—what they are doing is diverting attention from the real issues. And 25 years from now, even with double-digit growth rates, they will still be less than 1 percent of the energy supplied to meet worldwide demand. I am more interested in staying focused on the 99 percent than the 1 percent."

Indeed, advocates of alternative energy must resist the rhetorical temptations to suggest that energy problems are easily solved. They are not. Relieving our dependence on oil in any meaningful way is going to take much greater investments of time, money, and political will. There is no silver bullet solution. But the difficulty of solving the problem does not make it any less necessary. The President's State of the Union address indicates that he understands this.

Whether or not one classifies America's oil dependence as an addiction, the bottom line is that with less than 5 percent of the world's population, the United States consumes 25 percent of its oil. If oil prices remain at $60 a barrel through 2006, we will spend about $320 billion on oil imports this year. Most of the world's oil is concentrated in places that are either hostile to American interests or vulnerable to political upheaval and terrorism. And demand for oil will increase far more rapidly than we expected just a few years ago. Within 25 years, the world will need 50 percent more energy than it does now.

With these basics in mind, my message is that the balance of realism has passed from those who argue on behalf of oil and a laissez faire energy policy that relies on market evolution, to those who recognize that in the absence of a major reorientation in the way we get our energy, life in America is going to be much more difficult in the coming decades. No one who cares about U.S. foreign policy, national security, and long-term economic growth can afford to ignore what is happening in Iran, Russia, Venezuela, or in the lobby of the Corinthia Hotel in Tripoli. No one who is honestly assessing the decline of American leverage around the world due to our energy dependence can fail to see that energy is the albatross of U.S. national security.

We have entered a different energy era that requires a much different response than in past decades. What is needed is an urgent national campaign led by a succession of Presidents and Congresses who will ensure that American ingenuity and resources are fully committed to this problem.

We could take our time if this were merely a matter of accomplishing an industrial conversion to more cost effective technologies. Unfortunately, U.S. dependence on fossil fuels and their growing scarcity worldwide have already created conditions that are threatening our security and prosperity and undermining international stability. In the absence of revolutionary changes in energy policy, we are risking multiple disasters for our country that will constrain living standards, undermine our foreign policy goals, and leave us highly vulnerable to the machinations of rogue states.

The majority of oil and natural gas in the world is not controlled by those who respect market forces. Geology and politics have created petro-superpowers that nearly monopolize the world's oil supply. According to PFC Energy, foreign governments control up to 77 percent of the world's oil reserves through their national oil companies. These governments set prices through their investment and production decisions, and they have wide latitude to shut off the taps for political reasons.

I am not suggesting that markets won't eventually come into play to move America away from its oil dependence. Eventually, be-

cause of scarcity, terrorist attacks, market shocks, and foreign manipulation, the high price of oil will lead to enormous investment in and political support for alternatives. Given enough time, overcoming oil dependence and imbalances is well within the scope of human, and indeed American, ingenuity. The problem is that such investment cannot happen overnight, and even if it did, it will take years or even decades to build supporting infrastructure and change behavior. In other words, by the time a sustained energy crisis fully motivates the market, we are likely to be well past the point where we can save ourselves. Our motivation will come too late and the resulting investment will come too slowly to prevent the severe economic and security consequences of our oil dependence. This is the very essence of a problem requiring government action.

The first step is to admit how grave the problem is. Hopefully, we will look back on President Bush's declaration that America is "addicted to oil" as a seminal moment in American history, when a U.S President said something contrary to expectations and thereby stimulated change. Like President Nixon using his anticommunist credentials to open up China or President Johnson using his Southern roots to help pave the way for the Civil Rights Act, President Bush's standing as an oil man would lend special power to his advocacy, if he chose to initiate an all-out campaign for renewable energy sources.

SIX THREATS

As a national security problem, energy is unique in that the risks we face from this single condition are diverse and are intensifying simultaneously. In fact, our energy dependence creates at least six different threats that could directly or indirectly undermine American security and prosperity. Each of these threats could be the subject of its own speech, but today, I will provide an abbreviated review.

First, as we have seen, oil supplies are vulnerable to natural disasters, wars, and terrorist attacks that can disrupt the lifeblood of the international economy. The entire nation felt the spike in prices caused by Hurricanes Katrina and Rita last year. But these shocks, which helped send the price of oil to $70 a barrel, were minor compared to what would occur if major oil processing facilities in Saudi Arabia were sabotaged. In late February, terrorists attempted such an attack. They penetrated the outer defenses of Saudi Arabia's largest oil processing facility with car bombs before being repulsed. A successful terrorist attack—either through conventional ground assaults, suicide attacks with hijacked aircraft, terrorist inspired internal sabotage, or other means—would be devastating to the world economy. Al-Qaeda and other terrorist organizations have openly declared their intent to attack oil facilities to inflict pain on Western economies.

Recently, we have also seen the shutdown of a fifth of Nigeria's production by militants, and Iraq's continuing struggle to expand its oil production capacity amidst terrorist attacks.

The vulnerability of oil supplies is not a new concern. But the lack of spare oil production capacity is new. As recently as 4 years ago, spare production capacity exceeded world oil consumption by

about 10 percent. As world demand for oil has rapidly increased in the last few years, spare capacity has declined to less than 2 percent. Thus, any major disruption of oil creates scarcity that will drive prices up.

These circumstances require massive expenditures to preserve our oil lifeline. One conservative estimate puts U.S. oil-dedicated military expenditures in the Middle East at $50 billion year.

Second, over time, even if oil and natural gas supplies are not disrupted in dramatic ways that produce local or global economic shocks, worldwide reserves are nevertheless diminishing. This is occurring within the context of explosive economic growth in China, India, Brazil, and many other nations. The demand for energy from these industrializing giants is creating unprecedented competition for oil and natural gas.

Americans paid 17 percent more for energy in 2005 than in the previous year. That increase accounted for 40 percent of the rise in the consumer price index. Last November, we spent more than $24 billion on oil imports, accounting for more than a third of our trade deficit.

To meet world oil demand, the International Energy Agency estimates a need for $17 trillion in investment, with the bulk going to the Middle East. But political and economic conditions may not let this investment happen. Even if some investment does occur and reserves prove to be much larger than anticipated, there is no guarantee that hostile governments will either choose to develop new capacity or make any new oil available to the United States.

In the decades to come, price will not be the only issue. We will face the prospect that the world's supply of oil may not be abundant and accessible enough to support continued economic growth in both the industrialized West and in large rapidly growing economies. As we approach the point where the world's oil-hungry economies are competing for insufficient supplies of energy, oil will become an even stronger magnet for conflict and threats of military action, than it already is.

Third, the use of energy as an overt weapon by producing nations is not a theoretical threat of the future; it is happening now. Oil and natural gas are the currency through which energy-rich countries leverage their interests against import dependent nations such as ours. Iran has repeatedly threatened to cut off oil exports to selected nations if economic sanctions are imposed against it. Similarly Hugo Chavez in Venezuela has issued threats of an oil export embargo against the United States.

In January, Ukrainians were confronted by a Russian threat to cut off natural gas exports in mid-winter if Ukraine did not submit to a four-fold price increase. Russia took action to deny some natural gas to Ukraine. The dispute led to sharp drops in gas supplies reaching European countries that depend on natural gas moving through Ukrainian pipelines from Russia. Russia charged that Ukraine was diverting gas intended for Austria, Italy, France, Hungary and other European nations. Eventually, the confrontation was resolved with a near doubling of the price of natural gas sold by Russia to Ukraine. In contrast, Russia did not inflict such a price increase on Belarus, considered by Moscow to be a good partner, compared to the pro-Western Ukrainian Government. The

episode underscored the vulnerability of consumer nations to their energy suppliers.

We are used to thinking in terms of conventional warfare between nations, but energy is becoming the weapon of choice for those who possess it. It may seem to be a less lethal weapon than military forces, but a natural gas shutdown to Ukraine in the middle of winter could cause death and economic loss on the scale of a military attack. Moreover, in such circumstances, nations would become desperate, increasing the chances of armed conflict and terrorism. The use of energy as a weapon might require NATO to review what alliance obligations would be in such cases.

Fourth, even when energy is not used overtly as a weapon, energy imbalances are allowing regimes in countries that are rich in oil and natural gas to avoid democratic reforms and insulate themselves from international pressure and the aspirations of their own people.

We are seeing Iran and Venezuela cultivate energy relationships with important nations that are in a position to block economic sanctions. For decades, we have watched Saudi Arabia and other gulf states use oil wealth to create domestic conditions that prevent movement toward democracy. In Russia and Nigeria, energy assets have offered opportunities for corruption. In many oil rich nations, oil wealth has done little for the people, while ensuring less reform, less democracy, fewer free market activities, and more enrichment of elites.

Beyond the internal costs to these nations, we should recognize that we are transferring hundreds of billions of dollars each year to some of the least accountable regimes in the world. Some are using this money to invest abroad in terrorism, instability, or demagogic appeals to populism.

At a time when the international community is attempting to persuade Iran to live up to its nonproliferation obligations, our economic leverage on that country has declined due to its burgeoning oil revenues. If one tracks the arc of Iran's behavior over the last decade, its suppression of dissent, its support for terrorists, and its conflict with the West have increased in conjunction with its oil revenues, which soared by 30 percent in 2005.

Sometimes observers comfort themselves with the thought that most U.S. imports come from friendly nations such as Canada and Mexico, rather than from Iran or other problematic countries. But oil is a globally priced commodity. Even if our dollars are not going directly to Iran, this does not mean that our staggering consumption of oil is not contributing to the price paid to Iran by other consumers.

Fifth, the threat of climate change has been made worse by inefficient and unclean use of nonrenewable energy. In the long run this could bring drought, famine, disease, and mass migration, all of which could lead to conflict and instability.

There are no unilateral solutions to climate change. I have urged the Bush administration and my colleagues in Congress to return to a leadership role on the issue of climate change. I have advocated that the United States must be open to multilateral forums that attempt to achieve global solutions to the problem of greenhouse gases.

Our scientific understanding of climate change has advanced significantly. We have better computer models, more measurements, and more evidence—from the shrinking polar caps to expanding tropical disease zones for plants and humans—that the problem is real and is caused by man-made emissions of greenhouse gases, including carbon dioxide from fossil fuels.

Sixth, our efforts to stem terrorist recruitment and prevent terrorist cells and training grounds in the developing world are being undercut by the high costs of energy. The economic impact of high oil prices is far more burdensome in developing countries than in the developed world. Generally, developing countries are more dependent on imported oil, their industries are more energy intensive, and they use energy less efficiently.

The United Nations Conference on Trade and Development estimates that non-OPEC developing nations spend 3.5 percent of their GDP or more on imported oil—roughly twice the percentage paid in the main OECD countries. World Bank research shows that a sustained oil-price increase of $10 per barrel will reduce GDP by an average of 1.47 percent in countries with a per-capita income of less than $300. Some of these countries would lose as much as 4 percent of GDP. This compares to an average loss of less than one half of one percent of GDP in OECD countries. Some nations, such as Nepal and the Democratic Republic of the Congo, would experience GDP losses from a sustained $10 increase in the price of a barrel of oil that are twice the amount of foreign assistance that they receive from the United States. Even a nation like Ethiopia, which receives the substantial sum of $134 million in U.S. assistance because it is a focus country of the President's AIDs initiative, would see almost all of this offset by a $10 oil price increase.

Last week I chaired a Senate Foreign Relations Committee hearing on the nomination of Randy Tobias to be the new Administrator for USAID. In this capacity he would oversee a large share of our foreign assistance budget, which now exceeds $20 billion per year. This budget is intended to meet our humanitarian goals, but its success is also directly linked to national security. But all of this effort and money, in essence, can be wiped out merely by an increase in the price of energy.

Without a diversification of energy supplies that emphasizes environmentally friendly energy sources that are abundant in most developing countries, the national incomes of energy poor nations will remain depressed, with negative consequences for stability, development, disease eradication, and terrorism.

Each of these six threats from energy dependence is becoming more acute as time passes. Any of them could be the source of catastrophe. Any realistic American foreign policy must redeploy diplomatic, military, scientific, and economic resources toward solving the energy problem.

The basic dilemma for U.S. energy policy is how can our Government speed up the transition to alternative renewable energy sources so that we can prevent irreparable harm to our nation or the world associated with these threats? The realist must ask: How can we shape our energy future before it shapes us in disastrous ways?

WORKING TOWARD ENERGY SECURITY

American energy policy to date has suffered from two fundamental flaws. First, we have let two decades of relatively cheap oil and natural gas deepen our dependence on imports. An approach that focuses on research, while ignoring deployment of new fuels will not meet our national security challenge.

The second flaw is that we have lacked a truly comprehensive energy policy with energy security as a strategic goal. American energy policy has been focused on a narrow definition of energy security that strived to ensure sufficient supplies at affordable prices. This has translated into policies promoting diversification in supplies of oil and natural gas, with little emphasis on energy alternatives. A policy that relies on a finite resource concentrated in a few countries is doomed to failure. Our long-term security and prosperity require sufficient, affordable, clean, reliable, and sustainable energy.

A first component of energy security is to ensure sufficient supplies. Our energy intensity per unit of GDP has steadily decreased, but our energy consumption is still projected to increase by more than a third over the next 25 years. This demand scenario is not inevitable. Public policy can do more to promote efficiency while still growing the economy. Expanded programs to enhance energy efficiency in appliances, building construction, and industry are all necessary to keep our energy intensity declining.

One third of our projected energy growth is in oil, a majority of which we have to import. I have cosponsored a bipartisan bill with Senators Bayh and Lieberman that would require federal agencies to implement a plan to reduce U.S. oil consumption by 10 million barrels a day by 2031. The legislation contains many provisions to enhance energy conservation—from tire efficiency to reduced school bus idling to light-weight materials research.

Automakers have a central role to play in improving our oil efficiency. We are working to close the SUV CAFE standards loophole, and to get more hybrids and flex-fuel vehicles on the road. A fleet of hybrid, and future plug-in hybrids, that run on E–85 could reduce our oil use by 10 million barrels a day. The bill I have cosponsored removes the cap on the number of tax rebates for hybrid vehicles. It also fosters demand by requiring that 30 percent of the government auto fleet be hybrids and advanced diesels. With increased demand for fuel efficient cars, new manufacturing facilities will be built that provide jobs for Americans.

In partnership with the American auto industry, we should provide a set of incentives that give them the opportunity to regain their strength and save jobs through innovation. This bill offers a 35-percent tax credit for automakers to retool their factories so that they can make fuel efficient, advanced technology vehicles.

Affordability of energy supplies also remains a key goal for energy security. Crude oil still hovers around $60 a barrel, and last October's price for natural gas was more than double what it had been in the previous year. These high energy prices increase inflation and inhibit future economic growth.

Elevated oil and natural gas prices do have the benefit of making alternative fuels more competitive. With the end of 20 years of low

oil and gas prices, investment in alternative fuels has surged. As more is invested, innovation in technology and production will drive prices down further. That is why it is so important to get the first cellulosic ethanol facilities up and running. The President said in his State of the Union Address that he wanted to make cellulosic ethanol "practical and competitive within 6 years." In fact, one plant is ready to be built in Idaho, and many others could be built within the 6-year timeframe. I have asked the President to make sure that the loan guarantees that Congress authorized for cellulosic ethanol production are in place by this summer.

As alternative fuels become more competitive, oil and gas producers have strong incentive to drop prices to kill the competition. Investors need to know that alternative energy initiatives will continue to be competitive. A revenue-neutral $35 per barrel price floor on oil would provide the security investors need. At this price, alternative fuels like cellulosic ethanol, shale and tar sands oil, and Fischer-Tropsch diesel could still compete with regular gasoline. Many analysts say that expensive oil is here to stay, but most energy investors are hesitant to take on that risk. A modest price floor for oil that we may never reach would provide a major stimulation for energy alternatives.

Long-term energy security also requires the use of clean energy, a third component of energy security. As long as we continue to consume fuels that do not burn cleanly or cannot have their damaging gases sequestered, we will continue to pay environmental costs and will remain vulnerable to a climate change induced disaster.

The Congress must pass legislation establishing a cap and trade mechanism. A cap and trade system would provide regulatory certainty, reward innovation to improve energy efficiency, and provide strong market incentives for clean renewable fuels. Any such system should give credit for carbon sequestration in coal-fired plants and allow farmers and foresters to sell credits for the carbon they sequester.

I have introduced a resolution that calls for America to lead other nations to new agreements under the United Nations Framework Convention on Climate Change. Thanks to new technology, we can control many greenhouse gases with proactive, progrowth solutions, not just draconian limitations on economic activity. Industry and government alike recognize that progress on climate change can go hand in hand with progress on energy security, air pollution, and technology development.

Even as we strive to reduce the prevalence of fossil fuel in our energy portfolio, pragmatism requires that we diversify to the greatest extent possible our sources of oil and natural gas. I have supported opening ANWR for exploration. While we continue to debate production there and on the outer continental shelf, we have to carefully consider both the security and economic benefits of more exploration, as well as the environmental costs.

We must also ensure that we are not wasting fossil fuel resources in end-use that could be fueled by other means. I am encouraged by DuPont's commitment to replacing petrochemicals with bio alternatives. This wise business choice leaves DuPont less

vulnerable to price spikes than competitors who still rely exclusively on oil and gas.

With natural gas prices high, there is now a shift to coal-fired electrical generation. New plants should favor coal, which we have in abundance, over natural gas. I continue to vigorously support the deployment of clean coal technology with carbon sequestration.

We can also use coal to reduce our oil dependence. The energy bill included legislation I coauthored with Senator Obama authorizing $85 million for federal research into the production of coal-based transportation fuels. One of the technologies that will be encouraged by this program, the Fischer-Tropsch process, yields a diesel fuel that is compatible with existing vehicle technology. It is superior to oil-derived fuel with respect to performance and emissions.

Another critical component of reliability is protection of the physical infrastructure and transit of our energy supplies. Terrorists have made clear their intentions to destroy refineries and pipelines worldwide. At home, in addition to power plants, ports, refineries, and platforms, we have 160,000 miles of oil pipelines. As the United States considers liquefied natural gas and nuclear facilities, we must be vigilant to the security implications.

While diversity in supplies at home and abroad is necessary for more reliable energy in the coming decades, diversification of sources for oil and gas is an outdated strategy that will never bring energy security. Reserves are too concentrated and infrastructure too vulnerable. Real diversity can only be achieved by an energy portfolio dominated by sustainable energy, the final component of energy security.

As we make policies to influence the composition of our future energy portfolio, we should strive to consume fewer hydrocarbons than we can produce domestically. This means more clean coal and renewable fuels of all types. I am encouraged that some states and municipalities are taking the initiative to increase their use of renewables. With Congressman Pete Visclosky, I am advocating a bill that will do that for Indiana.

Our policies should be targeted to replace hydrocarbons with carbohydrates. Obviously this is not a short-term proposition, but we can off-set a significant portion of demand for oil by giving American consumers a real choice of automotive fuel. We must end oil's near monopoly on the transportation sector, which accounts for 68 percent of American oil consumption.

I believe that biofuels, combined with hybrid and other technologies, can begin to move us away from our extreme dependence on oil in the next decade. Corn-based ethanol is already providing many Midwesterners with a lower cost fuel option. Most of this is in a 10-percent ethanol mix, which is fully compatible with nearly all vehicles. I have recently called for my home State of Indiana to mandate that all gas stations in the state offer a 10-percent blend.

Cellulosic ethanol, which is made of more abundant and less expensive biomass, is poised for commercial take-off. I am pleased the President now supports the ethanol research that began under my legislation in 2000. I have long championed a renewable fuels standard, and we finally passed a 7.5 billion gallon ethanol mandate in the 2005 energy bill. The bill I am cosponsoring with Sen-

ators Bayh and Lieberman will increase the proportion of ethanol from cellulose that will be in that mix.

As our domestic ethanol industry strengthens and demand grows, we will have to revisit the tariff we put on ethanol imports. We do not want to trade oil import dependency for biofuel import dependency, but trade in alternative energy also creates jobs, provides new markets for our advance technology, and diversifies our own supply. In the end, I believe the United States is well positioned to produce ethanol at competitive rates.

We have to make sure that consumers have access to E–85 ethanol. Already there are millions of E–85 capable vehicles on the road. I have introduced legislation that would require manufacturers to install flexible-fuel technology in all new cars in the next 10 years. This is an easy and cheap modification, which allows vehicles to run on a mixture of 85 percent ethanol and 15 percent gasoline, and will make their products more attractive to consumers.

Next we have to make sure that consumers can buy the E–85 fuel. I'm pleased that many independent gas station owners are taking advantage of the tax credit for E–85 pump installation that we passed in the energy bill. I have cosponsored legislation that would back loans for even more E–85 pumps. The next challenge is to get E–85 distributed through the big gas station chains. I've asked the oil majors about this, and they have said that sufficient demand for E–85 does not exist. But demand will not develop for something that consumers do not have an option to buy. It is time for the oil companies to make E–85 available to the consumer. If these companies do not take advantage of the incentives Congress has provided, I would be in favor of legislation mandating that they install E–85 pumps in appropriate markets.

There is still more work to be done to tilt our energy balance toward alternative fuels. That is why Senator Obama and I will soon introduce a new bill that will promote other means to move these fuels into additional markets and make them more widely available for consumers. Among many provisions, the Obama-Lugar bill would create an alternative diesel standard comparable to the renewable fuels standard that I helped put into the 2005 energy bill. It would also provide new incentives for the production of flexible fuel vehicles. We believe that U.S. national security will be served by more robust coordination of all the elements that contribute to energy security. Consequently, the bill also would establish the post of Director of Energy Security, who would answer to the President.

ENERGY PARTNERSHIPS

As we pursue energy security at home, we must seek energy partnerships abroad. This week, I will introduce framework legislation that calls for a realignment of our diplomatic priorities to meet energy security challenges. Partnerships with foreign governments can help speed our conversion to real energy security, rebalance power in geopolitics, and open new markets for fuel technologies.

The "Energy Diplomacy and Security Act" calls upon the Federal Government to expand international cooperation on energy issues. This bill will enhance international preparedness for major disruptions in oil supplies. A particular priority is to offer a formal coordi-

nation agreement with China and India as they develop strategic petroleum reserves. This will help draw them into the international system, providing supply reassurance, and thereby reducing potential for conflict.

The bill would also stimulate regional partnerships in the Western Hemisphere. Most of our oil and virtually all of our gas imports come from this Hemisphere. The bill creates a Western Hemisphere Energy Forum modeled on the APEC energy working group. This would provide a badly needed mechanism for hemispheric energy cooperation and consultation.

Finally, the bill calls for international partnerships with both energy producers and consumers. In addition to seeking new avenues of cooperation, the bill is intended to give focus to existing bilateral energy dialogues, which have lacked clear objectives and political backing.

We must engage major oil and natural gas producers. We should advocate more transparency, improved investment climates, and greater infrastructure security. Oil exporting states wield power for which we must account. Not working with these states will lead to unproductive political showdowns and conflict. Even in challenging relationships such as Venezuela and Russia, we must explore how to improve our energy dialogue.

Strategic energy partnerships with other major consuming countries are crucial for our national security. Energy security is a priority we hold in common with other import dependent countries, which constitute 85 percent of the world's population. Strategic partnership for energy security with the world's largest consumers will increase leverage in relation to petro-states. In November, I introduced S. 1950, a bill that specifically targets India for enhanced cooperation on alternative energy sources, such as clean coal technology and biofuels.

To close, I would like to express my optimism for the future. Our current energy balance is the result of industrial and consumption choices of the past. Despite our import dependence today, the United States is in a strong position to choose a different path, a path toward real energy security. Success would free future generations of Americans from the energy dilemma that threatens to compromise our security and prosperity. It could also lead to opportunities in many new industries that could reinvigorate our economy. These are problems that can be solved. We must act now. We must act together.

Thank you.

"OIL DEPENDENCE AND ECONOMIC RISK"

Wednesday, June 7, 2006

OPENING STATEMENT

HON. RICHARD G. LUGAR

U.S. SENATOR FROM INDIANA,
CHAIRMAN, SENATE COMMITTEE ON FOREIGN RELATIONS

The Foreign Relations Committee meets today to continue our examination of the geopolitical consequences of energy imbalances and U.S. dependence on energy imports. In previous hearings, we have focused on quantifying the costs of U.S. energy dependence and examining options for improving our energy security. We also have explored in detail how energy is shaping our relationships with other nations, including India, China, and the Persian Gulf states. Later this month, we will have hearings that look at energy in the context of our relationships with Latin America and Russia.

Today, with the help of our esteemed witness, former Federal Reserve Chairman Alan Greenspan, we will have a unique opportunity to examine the economic effects of U.S. energy dependence. We are delighted that Chairman Greenspan has joined us today. He has given extraordinary service to our country over many years, and nobody speaks with greater authority on the U.S. economy. His presence here, for his first congressional testimony since leaving the Federal Reserve, is a testament to the economic importance he ascribes to solving our energy dilemma.

The Foreign Relations Committee has devoted intense scrutiny to energy issues because we believe that America's national security and economic well being depend on reducing our dependence on foreign oil and establishing more predictable, transparent, and cooperative relationships with both producer and consumer nations. To this end, I have introduced the Energy Diplomacy and Security Act. This bill would strengthen U.S. diplomatic capabilities related to energy and encourage greater international cooperation on energy security.

As Secretary Rice stated before this committee, our diplomatic activities around the world are being "warped" by petro-politics. Important foreign policy goals—from accelerating progress in the developing world and expanding trade, to preventing weapons proliferation and promoting democratic reform—are being undermined by international energy imbalances that have weakened our foreign policy leverage, while strengthening the hand of oil-rich authoritarian governments. In a speech in March at the Brookings Institu-

tion, I outlined these dynamics in greater detail, and I ask those remarks be entered into the record.

As recently as 4 years ago, spare production capacity exceeded world oil consumption by about 10 percent. As world demand for oil has rapidly increased in the last few years, spare capacity has declined to less than 2 percent. Any major disruption of oil creates scarcity that will drive prices up. Our vulnerability was made clear to Americans after the devastation of Hurricanes Katrina and Rita. But even as supplies rebounded from those disasters, we experienced a continued upward trend in oil prices. Events such as the civil unrest in Nigeria, uncertainty over Iran's nuclear program, and worries over Venezuelan supply have kept the price of oil above $70 a barrel.

Our capacity to deal with these energy vulnerabilities in a foreign policy context is shaped in part by the ability of our own economy to adjust to changing energy markets. Eventually, because of scarcity, terrorist threats, market shocks, and foreign manipulation, the high price of oil will lead to enormous investment in and political support for alternatives. The problem is that by the time sufficient motivation comes to markets, it may be too late to prevent the severe economic and security consequences of our oil dependence.

Today, we will have the benefit of Chairman Greenspan's insights into the risks of oil dependency to our economic prosperity. We are interested in a clearer picture of how current high energy prices are affecting our economy, how our economy may react to certain types of supply disruptions, and what steps we should take as a nation to reduce the economic risks of our energy vulnerability.

We welcome Chairman Greenspan to the Foreign Relations Committee and thank him for lending his expertise to our ongoing inquiry.

OPENING STATEMENT

HON. JOSEPH R. BIDEN, JR.

U.S. SENATOR FROM DELAWARE,
MINORITY LEADER, SENATE COMMITTEE ON FOREIGN RELATIONS

Dr. Greenspan, welcome.

Mr. Chairman, today's headlines make clear just how important this hearing is. On one hand, we have concern about inflation—led by petroleum-based energy costs that increased at a 61-percent annual rate in the first quarter of this year.

And on the other hand, we have our financial markets roiled by the worry that the Federal Reserve's prescription—continuing a course of 15 straight rate increases—could put the brakes on an economy that may already be slowing down.

We could not have clearer evidence of our country's vulnerability to global oil prices.

I am pleased to be working with you, Mr. Chairman, on this series of hearings on the cost of our dependence on imported oil, and to join you in our search for alternatives.

Today we are privileged to have former Federal Reserve Chairman Alan Greenspan, who guided our Nation's monetary policy for almost two decades, through a wide variety of domestic and international challenges, and through profound changes in our economy.

No one in the world who spoke on economic affairs was more listened to than Alan Greenspan. Not always understood, but listened to. It is a little daunting to have before this committee not only someone of your stature, Dr. Greenspan, but someone who once warned an audience, "If I turn out to be particularly clear, you've probably misunderstood what I said."

Your pronouncements can still move markets, but I hope your new life in the private sector will allow you more freedom of speech than you enjoyed in your last job.

We will need candor and clarity, if we are to understand and confront the challenges before us.

The last time you appeared before this committee, we were facing the Peso crisis, the first wave of international financial crises in the late 1990s. The topic of today's hearing presents threats of a similar magnitude to our economy, and to our security.

Today we are concerned about fundamentals, about the fuels that make our economy run, and about threats to our economic security because we do not control access to those fuels. And we are looking for ways we can move to more secure sources in the near future.

Our failure to set a national energy policy to reduce our consumption of oil has handcuffed our foreign policy and weakened us economically.

Global oil consumption—especially with the extremely rapid modernization of countries like China and India—is growing faster than the discovery and development of new supplies.

Supply has never been so tight relative to demand. We now live in a world that consumes 85 million barrels of oil every day. It's an enormous amount. Meanwhile, worldwide spare production capacity has shrunk to just 2 percent of demand. And that means the slightest thing—a terrorist attack in Saudi Arabia, tough talk from Iran, violence in Nigeria, or even a bad storm in our own gulf region—can cause oil markets to panic.

Here in the Foreign Relations Committee, we deal every day with the foreign policy implications of our dependence on imported fossil fuels. Most obviously, there are our complex relationships with what Michael Mandelbaum and others have called the "Axis of Oil," the oil-rich regimes around the world.

This dependence has a pernicious effect on our foreign policy. It literally helps to fuel the terrorism we are fighting, because some of the dollars we spend on crude oil wind up in the pockets of radicals. It limits our options and limits our leverage in dealing with national security threats, because oil rich countries can stand up to us, and oil dependent countries are afraid to stand with us. And it undercuts our hopes for advancing democracy and freedom, because repressive regimes, swimming in a sea of high-priced oil, can resist pressure to reform.

To cite just one example, Iran's most recent threats to disrupt oil exports—as a direct response to our attempts to deal with their nuclear ambitions—was immediately translated into an increase in oil prices—a jump to $73 a barrel. Not just economic forces, but political conflicts, drive this market.

We are here today to hear from Dr. Greenspan about the economic impact of oil and gas prices. During his long tenure as Chairman of the Federal Reserve, oil and gas prices spiked dangerously several times.

Dr. Greenspan has repeatedly warned us about the potential impact of those fundamental energy prices on inflation as they worked their way through the economy, as well as their potential to slow economic activity as consumers and producers moved limited dollars from other sectors to cover energy costs.

In your last Monetary Report to Congress last year, Dr. Greenspan, you placed significant stress on the potential problems that could arise from the jump in energy prices. You reported then that the impact they could have on consumer spending—the hit to the average American's pocketbook—would depend on how much incomes were growing. On that front, the news is not encouraging.

The latest reports from the job market show yet another disappointingly small increase in the number of Americans finding work, and the persistence of very troubling stagnation in wages. Something is wrong, this far into an economic recovery, when the job picture is this weak.

Wages are still flat—up just a penny an hour. That's 40 cents for a 40-hour work week. And the cost of living—including the cost of gasoline, and everything made and transported with petroleum—continues to grow faster than incomes.

The cost of gasoline went up over 2 cents a gallon last week. That's over 40 cents more for a 20-gallon tank of gas. That means that higher prices for gasoline really hurt real families. Gas is pretty much a fixed cost for the average American family who can't switch cars or move closer to work. For them, this is not an abstract discussion.

Here is what the wall Street Journal wrote last Friday: "Rising Energy Costs Pinch Low-Income Shoppers."

Slow job growth, flat wages—American households are part of the context we need to understand the impact of oil prices. In the bigger picture, our dependence on foreign oil feeds a cycle of dependence on foreign lenders to finance it.

Our trade deficit through March this year was $192 billion—that's 6 percent of our economy. Thirty percent of that deficit—$65 billion—was the cost of our petroleum imports. That number could grow to $100 billion this year.

To finance that trade deficit, we are borrowing from other countries. The supply of our debt will eventually outrun demand. As we are already seeing, that means a weaker dollar, making importing oil—and the thousands of other consumer goods from cars to computers—even more expensive. Until we do something about our dependence on imported oil we will not be in control of our economic security.

We can restore our energy security by reducing our consumption of oil. We can make the most progress, in the shortest amount of time if we focus on the fuel we put in our cars and trucks. Seventy percent of the oil we consume is used in transportation. We can immediately begin reducing our oil consumption by switching to fuels we can grow at home and making better, more efficient use of the energy we consume.

First we need to make sure we're all driving good cars by increasing fuel efficiency and requiring that every car sold in the United States is a flexible-fuel vehicle or FFV—that can run on alternative fuel like E–85—an 85-percent ethanol fuel blend.

Second, we need to make sure that we're using good fuel by requiring that major oil companies add alternative fuel pumps to at least half of their gas stations. Finally, we need to put in place the market and infrastructure for alternative fuels so that as new, more advanced fuel technology—like cellulosic (switchgrass) ethanol—becomes widely available we have the cars and pumps for it ready to go.

We have asked you here today to help us understand better the shape we are in today, and to draw on your experience to understand how we can manage the future.

I look forward to your statement, Dr. Greenspan, and to a discussion of these and other issues before us.

Thank you, Mr. Chairman.

PREPARED STATEMENT

HON. ALAN GREENSPAN

PRESIDENT, GREENSPAN ASSOCIATES LLC, WASHINGTON, DC

BEFORE THE

U.S. SENATE COMMITTEE ON FOREIGN RELATIONS

JUNE 7, 2006

Mr. Chairman, Senator Biden, and members of the committee, this morning I shall try to detail how the balance of world oil supply and demand has become so precarious that even small acts of sabotage or local insurrection have a significant impact on oil prices. American business, to date, has largely succeeded in finding productivity improvements that have contained energy costs. American households, however, are struggling with rising gasoline prices.

Even before the devastating hurricanes of last summer, world oil markets had been subject to a degree of strain not experienced for a generation. Oil prices had been persistently edging higher since 2002 as increases in global oil consumption progressively absorbed the buffer of several million barrels a day in excess capacity that stood between production and demand. Today world oil production stands at about 85 million barrels a day, and little excess capacity remains. Just how much excess capacity, and of what quality oil, is a matter of debate. But no matter what the precise answer, the buffer between supply and demand is much too small to absorb shutdowns of even a small part of the world's production. Moreover, growing threats of violence to oilfields, pipelines, storage facilities, and refineries, especially in the Middle East, have increased the private demand to hold oil inventories worldwide. Oil users judge they need to be prepared for the possibility that at some point a raid will succeed, with a devastating impact on supply.

For most of the history of oil, its producers and consumers determined its price. Only those who could physically store large quantities of oil had the ability to trade. But important advances in finance have opened the market to a much larger number of participants. There has been a major upsurge in over-the-counter trading of oil futures and other commodity derivatives. Thus, when in the last couple of years it became apparent that the world's oil industry was not investing enough to expand crude-oil production capacity quickly enough to meet rising demand, increasing numbers of hedge funds and other institutional investors began bidding for oil. They accumulated it in substantial net long positions in crude oil

futures, largely in the over-the-counter market. These net long futures contracts, in effect, constituted a bet that oil prices would rise. The sellers of those contracts to investors, when all of the offsetting claims are considered, are of necessity the present owners of the billions of barrels of private inventories of oil held throughout the world—namely, the producers and consumers.

Even though inventories of oil have risen significantly in recent years, persistent upward price movements have made it apparent that the rise in investors' ownership claims to the world's oil inventories has likely exceeded the inventory increase. This implies a reduction in the unencumbered inventory holdings of producers and consumers. In other words, some part of the oil in the world's storage tanks and pipelines is spoken for by investors. The extent of the surge in participation by financial institutions in claims on real barrels of oil is reflected in the near tripling of the notional value of commodity derivatives (excluding precious metals) during the four quarters of 2005 reported by U.S. commercial banks. Most of those contracts are for oil. The accumulation of net long positions in oil on the New York Mercantile Exchange by noncommercial traders , which is to say by investors, has exhibited a similar pattern.

The new participants, investors, and speculators, to the world's $2 trillion a year oil market are hastening the adjustment process that has become so urgent with the virtual elimination of the world supply buffer. With the demand from the investment community, oil prices have moved up sooner than they would have otherwise. In addition, there has been a large increase in oil inventories. In response to higher prices, producers have increased production dramatically and some consumption has been scaled back. Even though crude oil productive capacity is still inadequate, it too has risen significantly over the past 2 years in response to price.

Hypothetically, if we still had the 10 million barrels a day of spare capacity that existed two decades ago, neither surges in demand nor temporary shutdowns of output from violence, hurricanes, or unscheduled maintenance would be having much, if any, impact on price. Returning to such a level of spare capacity appears wholly out of reach for the foreseeable future, however. This is not because there is any shortage of oil in the ground. The problem is that aside from Saudi-Aramco, few, if any, of national oil companies which own most of the world's proved oil reserves are investing enough of their surging cash flow to convert the reserves into crude oil productive capacity. Only Saudi-Aramco appears sufficiently concerned, at least publicly, that high oil prices will reduce the long-term demand for oil, which could significantly diminish the value of Saudi Arabia's—or indeed, any country's—oil reserves.

Although outlays on productive capacity are rising, the significant proportion of oil revenues held as financial assets suggests that many governments perceive that the benefits of investing in additional capacity to meet rising world oil demand are limited. Moreover, much oil revenue has been diverted to meet the perceived high-priority needs of rapidly growing populations. Unless those policies, political institutions, and attitudes change, it is difficult to envision a rate of reinvestment by these economies adequate to meet rising world oil demand. Some members of the Orga-

nization of Petroleum Exporting Countries (OPEC) have recently announced expansion plans. But how firm such plans are, is difficult to judge. They and other nations have rebuffed offers by international oil companies to help tap their reserves. Opportunities to expand oil production elsewhere are limited to a few regions, notably the former Soviet Union.

Besides feared shortfalls in crude oil capacity, the adequacy of world refining capacity has become worrisome as well. Over the past decade, crude oil production has risen faster than refining capacity. A continuation of this trend would soon make lack of refining capacity the binding constraint on growth in oil use. This may already be happening in certain grades of oil, given the growing mismatch between the heavier and more sour content of world crude oil production and the rising world demand for lighter, sweeter petroleum products.

There is thus a special need to add adequate coking and desulphurization capacity to convert the average gravity and sulphur content of much of the world's crude oil to the lighter and sweeter needs of product markets, which are increasingly dominated by transportation fuels that must meet ever more stringent environmental requirements. Yet the expansion and modernization of world refineries are lagging. For example, no new refinery has been built in the United States since 1976. The consequence of lagging modernization is reflected in a significant widening of the price spread between the higher priced light sweet crudes such as Brent which are easier to refine and the heavier crudes such as Maya, which are not.

To be sure, refining capacity does continue to expand, albeit too gradually, and oil exploration and development is continuing, even in industrial countries. Conversion of the vast Athabasca oil sands reserves in Alberta to productive capacity, while slow, has made this unconventional source of oil highly competitive at current market prices. However, despite improved technology and high prices, additions to proved reserves in the developed world have not kept pace with production; so those reserves are being depleted.

The history of world petroleum is one of a rapidly growing industry in which producers have sought to provide consumers with stable prices to foster the growth of demand. In the first decade of the 20th century, pricing power was firmly in the hands of Americans. Even after the breakup of the Standard Oil monopoly in 1911, pricing power remained with the United States—first with the U.S. oil companies and later with the Texas Railroad Commission, which would raise limits on output to suppress price spikes and cut output to prevent sharp price declines.

Indeed, as late as the 1950s, crude oil production in the United States (more than 40 percent of which was in Texas) still accounted for more than half of the world total. In 1951, excess Texas crude was poured into the market to contain the impact on oil prices of the nationalization of Iranian oil. Excess American oil was again released to the market to counter the price pressures induced by the Suez crisis of 1956 and the Arab-Israeli war of 1967.

American oil's historical role ended in 1971, when rising world demand finally exceeded the excess crude oil capacity of the United States. At that point, the marginal pricing of oil abruptly shifted—

at first to a few large Middle East producers and later to market forces broader than they, or anyone, can contain.

To capitalize on their newly acquired pricing power in the early 1970s, many producing nations, especially in the Middle East, nationalized their oil companies. The full magnitude of the pricing power of the nationalized companies became evident in the aftermath of the oil embargo of 1973. During that period, posted crude oil prices at Ras Tanura, Saudi Arabia, rose to more than $11.00 per barrel, far above the $1.80 per barrel that had been unchanged from 1961 to 1970. The further surge in oil prices that accompanied the Iranian Revolution in 1979 eventually drove up prices to $39 per barrel by February 1981. That translates to $76 per barrel in today's prices.

The higher prices of the 1970s abruptly ended the extraordinary growth of U.S. and world consumption of oil and the increased intensity of its use which were hallmarks of the decades following World War II. Since the more than tenfold increase in crude oil prices between 1972 and 1981, world oil consumption per real dollar equivalent of global gross domestic product (GDP) has declined by approximately one-third.

In the United States, between 1945 and 1973, consumption of petroleum products rose at a startling average annual rate of 4.5 percent, well in excess of growth of our real GDP. However, between 1973 and 2006, U.S. oil consumption grew, on average, at only .5 percent per year, far short of the rise in real GDP. In consequence, the ratio of U.S. oil consumption to GDP fell by half.

Much of the decline in the ratio of oil use to real GDP in the United States has resulted from growth in the proportion of GDP composed of services, high-tech goods, and other less oil-intensive industries. The remainder of the decline is due to improved energy conservation: greater home insulation, better gasoline mileage, more efficient machinery, and streamlined production processes. These ongoing trends seem to have intensified of late with the sharp, recent increases in oil prices.

To date, it is difficult to find serious erosion in world economic activity as a consequence of sharply higher oil prices. Indeed, we have just experienced one of the strongest global economic expansions since the end of World War II. The United States, especially, has been able to absorb the huge implicit tax of rising oil prices so far. However, recent data indicate we may finally be experiencing some impact.

Clearly, if the current almost nonexistent supply buffer were significantly increased through a step-up in supply or a stepdown in consumption, oil prices would fall, perhaps sharply. This would likely occur even if there were no decrease in the threat to oil facilities from attacks or hurricanes. A large enough buffer could absorb such contingencies with modest impact on price.

But for good reason, holders of claims to the existing private inventories of oil apparently do not foresee a likelihood of change sufficient to alter the current outlook. This does not mean that oil prices will necessarily move higher, however. All of the concerns about future contingencies are already discounted in today's spot price. It will require a change in the outlook one way or the other to move crude oil prices. History tells us that will happen—often.

The U.S. economy has been able to absorb the huge impact of rising oil prices with little consequence to date because it has become far more flexible over the past three decades owing to deregulation and globalization. Growing protectionism would undermine that flexibility and make our nation increasingly vulnerable to the vagaries of the oil market.

Current oil prices over time should lower to some extent our worrisome dependence on petroleum. Still higher oil prices will inevitably move vehicle transportation to hybrids, and despite the inconvenience, plug-in hybrids. Corn ethanol, though valuable, can play only a limited role, because its ability to displace gasoline is modest at best. But cellulosic ethanol, should it fulfill its promise, would help to wean us of our petroleum dependence, as could clean coal and nuclear power. With those developments, oil in the years ahead will remain an important element of our energy future, but it need no longer be the dominant player.

"ENERGY SECURITY AND OIL DEPENDENCE"

Tuesday, May 16, 2006

OPENING STATEMENT

HON. RICHARD G. LUGAR

U.S. SENATOR FROM INDIANA,
CHAIRMAN, SENATE COMMITTEE ON FOREIGN RELATIONS

The Foreign Relations Committee meets today to consider strategies for reducing dependence on oil. This dependence brings intolerable costs to American national security and economic well being. If oil averages just $60 a barrel this year, the import cost to the U.S. economy will be approximately $320 billion. This revenue stream emboldens difficult oil-rich regimes and enables them to entrench corruption and authoritarianism, fund anti-Western demagogic appeals, and support terrorism. As global oil demand increases and the world becomes more reliant on reserves concentrated in unstable regions, the likelihood of conflict over energy supplies will dramatically increase, and energy rich countries will have more opportunity to use their energy exports as weapons against energy poor nations.

High prices over the past 10 months have demonstrated the vulnerability of supply. A global oil market tightened by under-investment in production and surging global demand has been aggravated by hurricanes, unrest in Nigeria, speculation about developments in Iran, weakened capacity in Venezuela, and terrorist activity in Iraq and elsewhere. In this environment, the price shock from a major supply disruption could cause a recession.

Today, we will concentrate on how our government can speed up the transition to alternative sustainable energy sources. We are cognizant that despite past campaigns for energy independence and a constant improvement in energy intensity per GDP, we are more dependent on oil imports today than we were when President Nixon authorized "Project Independence" in 1973. Yet, I believe that we are turning a corner. The American public and elected officials are becoming more aware of the severe problems associated with energy dependence and are more willing to take aggressive action.

The new realism of energy geopolitics requires us to abandon the notion that simply finding more oil will solve oil-driven threats to our national security. More than three-quarters of the world's oil reserves are controlled by foreign governments. With global oil demand projected to rise from 83 million barrels a day to 120 million

barrels per day by 2030, the security threats related to oil dependence will continue to intensify, unless we make dramatic changes in policy.

Efforts to reduce oil consumption must focus on developing sustainable fuels and increasing efficiency. I am pleased that the first commercial scale cellulosic ethanol plant in the United States is ready for construction and that Americans are beginning to demand more fuel efficient vehicles. We must continue investing in advanced energy research, but threats to our national security require us to efficiently deploy the oil-saving technology that is available now.

The benefits of reducing oil use at home will multiply when other countries also switch to alternative fuels and decrease the energy intensity of their economies. I have introduced S. 2435, the Energy Diplomacy and Security Act to reorient our diplomatic activities to give greater priority to energy matters. We need bold international partnerships to blunt the ability of producer states to use energy as a weapon, to increase our own security of supply, and to reduce the vulnerability of our economy to high oil prices.

Today we will benefit from the views of two distinguished experts. We will ask them to identify the best options for reducing oil use through alternatives and efficiency gains. We will also seek their counsel on what government can do to accelerate the transition away from oil and how we can most effectively encourage helpful actions by the private sector and consumers.

First, we will hear from Mr. Vinod Khosla, the founding partner of Khosla Ventures, a leading venture capital firm that has invested in many cutting edge energy technologies. A cofounder of Sun Microsystems, Mr. Khosla, is an influential voice on the viability of alternative energy sources. Next, we will hear from Mr. Jason Grumet, Executive Director of the National Commission on Energy Policy. In December 2004, the bipartisan commission released its recommendations for a long-term energy strategy. The report comprehensively examined numerous technologies and methods for increasing energy supplies, as well as for moderating energy demand. Prior to joining the Commission, Mr. Grumet served as Executive Director of Northeast States for Coordinated Air Use Management.

We welcome our witnesses and look forward to their insights.

OPENING STATEMENT

HON. JOSEPH R. BIDEN, JR.

U.S. SENATOR FROM DELAWARE,
MINORITY LEADER, SENATE COMMITTEE ON FOREIGN RELATIONS

With gasoline at $3 a gallon, and with our most pressing foreign policy challenges centered in the oil-producing countries of the world, today's hearing before the Foreign Relations Committee could not be more timely or more important.

We heard a few weeks ago in this committee about the hidden costs of our dependence on foreign oil. The United States has just one-third of the world's oil reserves, and less than 5 percent of its population, but we consume fully one-third of the global oil output.

Over 60 percent of the world's oil reserves are held in the Middle East, and as one of our witnesses points out today only 9 percent of world reserves are held in countries we would call "free."

We are dependent on oil, and that makes us dependent on countries with whom we will continue to have at best many differences and at worst open hostility. What Michael Mandelbaum has called "the axis of oil"—an axis that stretches from Russia to Iran to Venezuela to Saudi Arabia—will have as great an impact on our national security as the so-called "axis of evil."

That dependence means we pay a huge price militarily for access to a resource that we cannot do without. One estimate suggests we pay as much as $825 billion a year in security expenditures to project our influence and secure access to oil.

Some part of every dollar we pay for imported oil finds its way into the hands of our sworn enemies. As some observers have put it, the war on terror is the first war in which we are paying for both sides in the conflict.

Disruption to our economy from interruptions in supply can be huge, and will grow as our dependence grows. As Alan Greenspan has warned us, all economic downturns since the 1970s have been preceded by spikes in the price of oil.

We pay a price environmentally for our dependence on oil, most profoundly in dealing with the repercussions of climate change, driven by our use of fossil fuels.

There can no longer be any doubt that our dependence on oil is a critical problem, one that must be addressed.

The sheer size of this problem is such that there will be no quick fix. Oil represents about 40 percent of our energy consumption and we import about 60 percent of the oil we use. Fully 70 percent of our transportation is dependent on oil. That statistic will not be transformed overnight.

But there are other statistics that will not change, as well. China has accounted for fully 40 percent of the recent increase in global oil demand. It will put another 120 million vehicles on the road over the next 5 years. Along with India, and a reindustrializing Eastern Europe, that growth in global demand is not going to be reversed.

The fit between global supply and demand today is extremely tight. Billions of dollars of new investment may keep pace with demand, but will do little to ease the price at the pump. And new supply, from conventional or unconventional sources of oil, will only hasten the process of climate change, and will simply delay our transition to the alternatives than can address our addiction to oil.

What are our alternatives to oil? In the short term, ethanol from corn could be a first step away from our oil addiction, by providing a liquid fuel that is compatible with existing internal combustion engines that power our cars, trucks, and buses. We will hear today about the costs and benefits of taking such a step, and the steps that must follow toward sugar or cellulosic ethanol.

Ethanol will be just part of a broader energy policy that will reduce our dependence on oil, and will reduce the leverage that the oil producing nations have over our foreign policy and our national security.

If it was not clear before, it is now. Domestic energy policy is at the center of our foreign policy.

PREPARED STATEMENT

VINOD KHOSLA

PARTNER, KHOSLA VENTURES, MENLO PARK, CA

BEFORE THE

U.S. SENATE COMMITTEE ON FOREIGN RELATIONS

MAY 16, 2006

Good Morning. Chairman Lugar and esteemed members of the committee, I want to start by thanking you for allowing me the opportunity to speak to you today about our unique ability to secure America's energy independence. Since the President's State of the Union Address and rising prices at the pumps, there has been a lot of talk about our oil addiction. I come here to talk not about what must be done but rather how to get it done, simply and pragmatically, in a manner aligned with the major political interests that carry clout in this country. We can not only do the right thing, but also the politically correct thing, if each interest group compromises a little.

If it were not for the rapid growth of our domestic ethanol industry, Americans would see gas prices approaching $4 a gallon with no real alternative or hope in sight. In comparison, the Department of Energy estimates ANWR drilling would save 1 cent per gallon at the pump by 2025. (As quoted in *Fortune* May 15, 2006) We could be the architect of a global development plan, a Marshall Plan for our times that would support technological advancements and sustainable development of a global alternative to petroleum . . . and best of all it takes very little money to do so.

I come to you today with ambitious goals, but goals that are grounded in sound science, technology and business. I am convinced that we can replace the majority of our petroleum used for cars and light trucks with ethanol within 25 years. This is not an alternative fuel—it can be a mainstream fuel. More importantly, with a few simple policy changes, we can be irreversibly traveling down this path in less than 7 years.

You may ask, "why ethanol"? Ethanol is substantially cheaper to produce today than gasoline before all subsidies and taxes. For example, the cost to produce ethanol in Brazil is less than $0.75 per gallon, while a U.S.-based corn-to-ethanol plant's production costs are roughly $1.00 per gallon. That equates, even with U.S. costs, to about $1.25 per "gasoline-equivalent" gallon of ethanol. Gasoline, on the other hand, costs $1.60–$2.20 or more per gallon to produce, depending upon the cost of a barrel of oil.

Why shouldn't ethanol sell for much less than gasoline at the pump? Oil interests distort the price to ensure they don't lose their lucrative profit opportunity or temporary supply/demand dynamics. As new technologies ramp up, ethanol can be cheaper than gasoline even if oil drops to $35–$40 per barrel—a level it is not expected to reach, according to the EIA. In addition to lower cost, E–85 reduces volatile organic compounds by 15 percent, carbon monoxide by 40 percent, NOX by 10 percent and sulfate emissions by 80 percent when compared to gasoline, according to an estimate from one environmental organization.

With ethanol, we get a fuel that is cheaper for consumers and automakers, cleaner and greener, and it takes Middle East terrorism-fueling dollars and moves them to rural America. We capitalize on American technology to create more jobs and cheaper transportation costs for the American public. What is wrong with this picture?

What is the single biggest risk we face from the oil interests distorting the price to ensure they don't lose their lucrative profit opportunity? If you were making $36 billion of profit per year like Exxon, would you want things to change? Reports of oil company executives lying under oath are reminiscent of the 1985 price manipulation episodes, Enron's energy price manipulation, and other examples, be they Iran, Russia or Sudan. I personally received a warning from a senior executive of a major oil company that they could drop the price of oil if biofuels started to take off. We cannot let this opportunity slip away again.

My friends from the Mid-West tell me ethanol is the talk of coffee shops there and may be the most important thing to hit rural America in 30 years. It may also be the most important thing for global peace and welfare, the climate crisis, and for consumers. Fortunately, at this time the environmentalists, the automakers the agricultural interests, the security and energy independence proponents, and even the evangelicals are all aligned. Finally, a cause all interests can rally behind. As Tom Freidman recites a New York Times poll: 89 percent of Americans favor a mandate of more efficient cars; 87 percent say no to a gasoline tax, but that figure drops to 37 percent if the tax is to "reduce our dependence on foreign oil" and to 34 percent if the tax is to "reduce global warming."

The oil interests keep propagating myths like insufficient land, poor energy balance, and high production costs to curb enthusiasm for ethanol. This is reminiscent of the tobacco companies funding studies to prove that smoking does not cause cancer. The NRDC, more concerned about land use than the oil interest, estimate a modest 114m acres of land needs. Argonne National Labs and UC Berkley among many others have discounted the energy balance claims. In my opinion, these are bogus if not ill-intentioned claims and I will address these falsehoods one by one.

Crop Land: Yields of corn are increasing in the United States and Brazil. Brazil has had a 4x increase since 1975 and knowledgeable scientists are forecasting another 4x in the next 10 years. U.S. gallons per acre yields can reach 10x the current levels even without the innovations that are commonplace in Silicon Valley. Based on my forecasts, I can see my way to yields increasing more than

10x to between 3,000 to 5,000 gallons per acre compared to 400 gallons per acre today, demolishing all land use and energy balance arguments. I agree with Rick Tolman, CEO of the National Corn Growers Association, who believes that corn can provide 14–17 billions of gallons of ethanol by 2015 without impacting food supply. Based on my forecasts, including the considerable upside afforded by technology innovations, biomass based ethanol can replace most of our gasoline needs in 20 years, using less than 60m acres of land.

Energy Balance: The only study that claims corn ethanol has an unfavorable energy balance is an outdated study performed by Professor Pimentel. Both USDA & DOE affiliated researchers claim that Pimentel's 2005 study overstates energy requirements. Professor Kammen at UC Berkley further states that corn ethanol results in a more than 90 percent reduction in petroleum use and a moderate 10–30 percent reduction in greenhouse gases. The NRDC agrees, stating that: (1) Corn ethanol provides important fossil fuel savings and greenhouse gas reductions; (2) cellulosic ethanol simply delivers profoundly more renewable energy than corn ethanol; and (3) very little petroleum is used in the production of ethanol. From this information, the conclusion is that a shift from gasoline to ethanol will reduce our oil dependence.

Though a 25-percent mileage reduction is the reality today, it can be immaterially small over time as engines are optimized for a flex-fuel world. Saab sells a model in Sweden that adjusts itself to take full advantage of E–85's higher octane—100 to 105, versus 87 to 93 octane for gasoline. Called the Saab 9–5 BioPower, its turbocharged engine generates 175 horsepower on gasoline and a whopping 215 hp on E–85. (USA Today, 5/4/2006). Even with the additional horsepower, the Saab 9–5 only has an 18-percent lower mileage on ethanol. If the engine was designed to provide the 175 hp on ethanol, we would get an additional substantial step increase in ethanol mileage. This proves that engines can be optimized for ethanol, thus substantially eliminating the mileage penalty which has been a convenient excuse for the oil companies.

In the United States in 2000 the ethanol industry sold about 1.6 billion gallons of ethanol at about $1.20 per gallon. By 2005, the industry more than doubled its sales to 4 billion gallons, at a price of about $1.50 per gallon. In my view plants can meet all their cash flow requirements and pay off construction debt at prices in the $1.30–$1.40 per gallon range, given a cost of production of roughly $1 per gallon without subsidies or tax credits. At today's prices of over $2.50 per gallon, ethanol producers can pay off their plants in just 11 months rather than the standard 7-year payoff period. It is indisputable that ethanol is not only cheaper to produce than gasoline at about $40/barrel, but also, that the returns can be outstanding. It is disturbing to me to see some factions calling for permanent extensions to the credits, instead of supporting a variable VEETC model, which is genuinely needed to prevent oil price manipulation by interested parties.

We have sufficient land and the energy balances and economics are favorable for ethanol as a transportation fuel. All we need to do is kick start the process.

Chairman Lugar and members of the committee, the time has come for us to ask ourselves: Do we want to feed our farmers or Middle-East terrorism? Do we want ANWR oil rigs or prairie grass fields? Fossil fuels or green fuels? Should we create farm jobs or Middle-East oil tycoons? Gasoline cars or cars that offer the choice of gasoline or biofuels? Expensive gasoline or cheaper ethanol? This appears to be nothing less than a Darwinian IQ test.

Risk capital from investors is the only solution to the oil stranglehold. Three simple things that need a little bit of courage, but not a lot of money are sufficient to get this capital flowing. These three are:

1. Mandate that at least 70 percent of the new cars sold in America be FFVs by 2014 with 10 percent annual increases starting with 20 percent by 2009, and that all such cars, old and new, be provided with yellow gas caps, with possible tax incentives of $50 per car.

2. Mandate that 10 percent of all gas stations owned or branded by major gas station owners offer at least one ethanol pump. Alternatively, mandating a separate RFS for E–85 and cellulosic ethanol, defined later, would serve a similar purpose. For the first 20,000 stations that convert at least one pump, an incentive can be offered up to $30,000 per station in the first year, $25,000 per station in the second year and $20,000 per year in the third year, the proceeds being appropriated from the Leaking Underground Storage Tank Fund or through a special tax on oil company profits, up to a maximum of $600m over 3 years.

3. Make VEETC credit variable with oil price varying from $0.20 at current prices up to $0.80 instead of the current $0.51 credit as oil prices vary from $70 to $30 per gallon. This will insure that OPEC or the National oil companies cannot manipulate prices as easily, hence driving ethanol producers out of business. Such credits should expire once ethanol capacity exceeds 15 billion gallons in this country.

These three policies will assure investors that a permanent market will exist for ethanol and will not be subject to price manipulation by the oil nations. Billions of dollars will flow into the ethanol economy creating a permanent alternative to gasoline, without material government funds.

In addition, certain other polices can accelerate the process but are not essential:

1. Shift the $0.51 blender's credit to an "ethanol producers' credit," preferably to be used only for plant construction instead of giving it to the oil companies as a "blender's credit." This will build permanent U.S. capacity for new ethanol production, independent of whether the ethanol is U.S.-made or imported. In fact, this format will supply all the capital required for plant construction the industry needs to replace all our petroleum and can be structured to be self-effacing when we reach appropriate plant capacity.

2. Allow imports of ethanol for consumption above the RFS standard without tariff, subject to switching the VEETC eth-

anol credit to one directed exclusively toward building plant capacity in the United States. This will create permanent capacity for ethanol production in the United States. It is likely that we will see WTO action challenging the tariff's legality. A proactive program is more likely to be effective than a reaction in hindsight to WTO action. Early availability of lower priced ethanol in the market will accelerate the switch to E–85 and take ethanol into the domain of a primary replacement for gasoline instead of just being an additive. Concurrent with this provision the ethanol RFS can be extended to 12b gallons by 2015. Based on the national security exemption of the WTO, an incentive or VEETC like credit is probably allowable if it is directed toward building ethanol fuel plant capacity in the United States. An alternative would be to eliminate the tariff only for E–85 ethanol use, accelerating E–85 adoption while keeping the blending market protected against imports. This would allow U.S. farmers to ease the learning curve on ethanol costs. Tariff removal could be coincident with funding of additional E–85 stations.

3. Institute a similar limited period credit for cellulosic ethanol or monetize the current "1.5 times" credit for cellulosic ethanol defined in the 2005 energy bill.

4. Institute separate RFS standards for E–85 (and possibly cellulosic ethanol) to kick start the E–85 market, which is currently being discouraged by the oil companies.

5. Reform and strengthen CAFE, replacing CAFE mileage with CAFE "petroleum mileage" to align and incentivize automakers to promote the use of ethanol and other gasoline alternatives, giving them credit for any technology used to replace petroleum; in addition to increases in mileage standards.

6. Provide loan guarantees for the first few cellulosic ethanol plants built with any new technology.

7. Institute a cap and trade system for carbon trading. This could effectively reduce the price of ethanol by as much as $0.20–$0.30 per gallon (based on the current trading price of carbon in the European Union) depending upon the ethanol production technology. This would provide incentives to make corn ethanol greener, and less dependent on fossil fuels.

8. Switch agricultural subsidies from row crops to energy crops.

As oil prices continue to soar in the United States, I see the following. First, oil companies use big budget advertising, expensive PR firms and armies of accountants to prove they are not making too much money while making more money than any industry has ever made in the history of the corporate world. It is amazing what money can buy.

Second, oil companies blame everybody but themselves, but more importantly are doing relatively little to invest in alternatives to gasoline, other than token investments and PR campaigns.

Third, they put obstacles in the way of their franchisees who want to offer ethanol instead of offering E–85 themselves. Why don't we require them to sell ethanol at least 10 percent of their

gas stations? We have CAFE standards for automakers, why not E–85 green fuel standards for the oil companies?

Finally, with a fraction of their oil profits invested in new ethanol capacity or ethanol distribution we could be producing tens of billions of gallons of ethanol and solving our addiction to oil. Instead they are sending these profits to the Mideast instead of creating jobs in the USA. Are they entitled to their profits? I believe they are. But that should not prevent us from developing alternatives to their stranglehold on our transportation fuel for the good of society. Here are some examples of why it is clear we need to reign in big oil:

1. Gov. Pataki proposed a new bill in New York. The bill would exempt renewable fuels from the provisions of "exclusivity" contracts between fuel providers and retail service stations, which only allow the service stations to sell specific brands of fuel. In most cases, these brands do not include renewable fuels. Since the "exclusivity" contracts prohibit service stations from obtaining renewable fuels like ethanol (E–85) from other sources, these fuels are not available for sale to consumers. The Governor's proposal would exclude renewable fuels from these contracts if the distributor does not offer these types of fuels.

2. A Mobil gas station in St. Louis does not allow the use of credit cards for payment and warns against ethanol. This is typical of how oil companies discourage consumer use with scary notices. An Exxon in Brazil stated that for all flex fuel vehicles every third fill-up should be with gasoline, another falsehood.

3. The Foundation for Consumer & Taxpayer Rights released a new study of rising gasoline prices in California that found corporate markups and profiteering are responsible for spring price spikes, not rising crude costs or the national switchover to higher cost ethanol, as the oil industry claims. One can find the study at: http://www.consumerwatchdog.org/energy/rp/6132.pdf

4. The 1985 price manipulation and recoupling of an economy that was decoupling from oil is well known.

Gaining independence from foreign oil would not be unique to the United States. I just recently returned from Brazil, which has declared independence from foreign oil. Let me share some insights with you.

I got a very instinctive good feeling about carbon capture. As I looked at sugarcane varieties capable of producing 200 (wet) tons per hectare I could imagine the sound of carbon dioxide getting sucked out of the atmosphere. My estimates of less than 60 million acres required to fuel most of America's cars and light trucks by 2030 started to feel conservative as I saw Brazilian entrepreneurs developing technologies to produce over 3,000 gallons per acre. Imagine what would happen if we let Silicon Valley entrepreneurs and American scientists and technologists innovate in this area. Some fraction of the land used for export crops could replace much of our gasoline needs. We must signal to our innovators that this is a long-term, large market, as Brazil has done.

As I saw bagasse roll off the conveyor belts into heaps of waste for burning, it struck me that because of the preprocessing already done on this waste material it could produce cellulosic ethanol very soon. Even today's semideveloped cellulosic ethanol processes could make economic sense without waiting for full development. Orange peels from Florida and wood chips from our Northwestern forests would be next in line.

It became clear that America, Brazil, Australia, India, and Africa could each produce enough ethanol to meet their local gasoline replacement needs and then export enough to serve much of the planet.

It was surprising to learn that the average wage at Cosan, the largest Brazilian ethanol producer, was many times the average for similar industries in Brazil. Over a million jobs had been created in the ethanol economy in Brazil. Ethanol produces substantially more jobs per dollar invested than oil does.

Almost astounding was the claim by some entrepreneurs that they could see technology driving costs well below 50 cents per gallon. There is no reason U.S. ethanol production costs won't come down too. The big manufacturers confirmed their ability to produce ethanol at below 75 cents a gallon today. Why are we paying over $3 a gallon for our gasoline?

If ethanol supplies run low Brazilian producers can switch production in hours away from sugar to produce more ethanol. Consumers constantly switch back and forth between ethanol and gasoline based on cost and availability. Wouldn't it be nice if consumers here had a choice and were not held hostage by oil companies?

It was embarrassing to see Brazilian experts laugh at the myths U.S. energy companies spread, like we cannot use the same storage tanks or tanker trucks or transport ethanol in pipelines. They have been doing this for years with no adverse consequences. Why do we let people interested in slowing down biofuels spread these myths by turning molehills into mountains? Surely, some issues exist but they are easily resolved in the context of a market as large as the transportation fuels market. I was passionate about ethanol before I went. Going there seemed to completely confirm the potential and opened my eyes to all sorts of new possibilities.

Finally, I will leave you with some thoughts on why now is the time to take action. We have a climate crisis, we have an energy crisis, and we have a terrorism crisis and they are all coupled. The price of oil is up, the cost of ethanol production is down and we have a visible climate crisis and an overwhelming terrorism crisis. Economics and the right thing coincide this time around. Consumer pull has been proven in Brazil. Our risks are minimal. According to the firm Expansion Capital Partners, clean, or green, technologies netted less than 1 percent of venture capital funds 6 years ago. Today, however, the figure has risen to 8 percent, the firm told TechNewsWorld. (http://www.technewsworld.com/story/50076.html) Recent news reports that the U.S. insurance industry has decided to formally study the relationship of global climate change to rising insurance costs and availability concerns.

Geopolitics & OPEC politics deserve a special mention. Venezuelan President, Hugo Chávez, is poised to launch a bid to transform the global politics of oil by seeking a deal with consumer

countries which would lock in a price of $50 a barrel, according to the Monday April 3, 2006 issue of "The Guardian." A long-term agreement at that price could allow Venezuela to count its huge deposits of heavy crude as part of its official reserves, which Caracas says would give it more oil than Saudi Arabia. A $50-a-barrel lock-in would open the way for Venezuela, already the world's fifth-largest oil exporter, to demand a huge increase in its official oil reserves—allowing it to demand a big increase in its production allowance within OPEC. Venezuela holds 90 percent of the world's extra heavy crude oil—deposits which have to be turned into synthetic light crude before they can be refined and which only become economic to operate with the oil price at about $40 a barrel. Newsnight cites a report from the U.S. Energy Information Administrator Guy Caruso suggesting Venezuela could have more than a trillion barrels of reserves.

Saudi Arabia's Oil Minister scorned the popular notion that America can achieve energy independence as a myth (SF Chronicle, May 3, 2006).

Iran, China, India, Sudan, Nigeria, Venezuela, Argentina, and Bolivia are all responding to the scramble for oil. Rules and principles go by the wayside given the urgency of energy needs for each nation.

Asset valuation—increase in Venezuela and Saudi Arabia (each) asset values of over a trillion for every $4 rise in the price of a barrel of oil. According to press reports, for similar reasons, the U.S. oil companies have resisted inventory revaluation methods proposed by FASB.

I came to you today with ambitious goals. I hope that you, too, are convinced that we can replace the majority of our petroleum used for cars and light trucks with ethanol within 25 years. More importantly, with a few simple policy changes, we can be irreversibly traveling down this path in less than 7 years and achieve energy independence, reduce greenhouse gas emissions, and create more jobs for rural Americans. I thank you for your time and attention.

PREPARED STATEMENT

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BEFORE THE

U.S. SENATE COMMITTEE ON FOREIGN RELATIONS

MAY 16, 2006

INTRODUCTION

Good day, Chairman Lugar and members of the committee. I have the privilege to speak to you today on behalf of the National Commission on Energy Policy (NCEP), a diverse and bipartisan group of energy experts that first came together in 2002 with support from the Hewlett Foundation and several other leading philanthropies. In December 2004, the Commission released a report entitled "Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges." The first chapter of that report was about oil security because our Commission believed then, and still does, that oil security is one of our nation's foremost economic, national security and energy challenges.

This isn't news to anyone, of course—least of all this committee. In fact, as national policy obsessions go, America's oil dependence has been one of our most enduring. For more than 50 years, Congress and multiple administrations of either party have decried our reliance on imported oil and vowed to do something about it. Today, with oil prices topping $70 per barrel and gasoline prices at $3 per gallon, we are again enmeshed in an active debate over energy policy. The lack of real options to address near-term energy prices is a source of great frustration here in Congress and throughout the country. The challenge we face is to move beyond slogans, blame, and false promise of "quick fixes" and seize upon this moment of collective focus to develop long-term policy responses that will meaningfully protect our economy while strengthening our national security.

The basic elements of an effective response to our current oil predicament are as easy to summarize as they are difficult to execute. Put simply, the Commission believes we must:

1. Expand and diversify supplies,
2. Reduce demand, and
3. Develop alternatives.

At the outset, I want to stress four themes that I hope will resonate throughout my remarks. First, the elements identified above are complementary components of an effective strategy. If they are not pursued in concert the effort will fail. We must have supply increases and demand reductions. We must pursue greater vehicle fuel economy and aggressive efforts to displace petroleum with biofuels. Simply put, we must move beyond divisive and false choices to develop a comprehensive approach that does not seek to trade one element off against the success of another.

Second, until, and unless, private markets reflect the full economic, security, and environmental costs of oil dependence—and until, and unless, consumers possess adequate information to make efficient choices—policies that rely solely on private market decisions will continue to fail. It is therefore incumbent upon government to overcome market barriers and motivate private sector innovation by creating incentives that better reflect the true benefits of greater energy security.

Third, improving our energy security is a long-term challenge. If we commit the nation to a fundamental course correction, a secure energy future is within our reach. It will take several years, however, before we begin to reap the benefits of improved policies and technologies. During this time, the problem of high prices and tight supplies will almost certainly get worse as growth in petroleum demand continues to outstrip the rate at which vehicle fuel economy improves and new sources of oil come on line. While biofuels hold great potential, near-term gains will also be incremental when compared against our annual petroleum consumption. If history is a guide, public interest and support for long-term policies will wax and wane as the price of gasoline rises and falls. A real solution therefore will require the kind of commitment, consistency, and courage our nation has mustered in the past when we understood that our future was at risk.

Finally, we must better understand and articulate the risks of oil dependence and establish goals that encourage consistent progress and accountability. I believe that our failure over the past 30 years to implement measures commensurate with the risks is in part due to widely held misconceptions about the true nature and scope of the problem and to our inability to establish realistic interim goals and mechanisms to measure our progress in achieving them.

Rethinking "Energy Independence"

Before delving into solutions, I would like to take on the somewhat heretical task of challenging the aspiration of "energy independence" with its attendant focus on reducing our nation's use of "foreign oil." While emotionally compelling, these concepts are vestiges of a world that no longer exists. By failing to recognize the fundamentally global nature of the oil market, and the increasingly global nature of markets for natural gas, the call for energy independence has become an obstacle to effective policy design. There is one world market for oil. It is a fungible global commodity that has a single benchmark price. Wide disparities in the price of gasoline around the world are the product of national subsidies and taxes, but have nothing to do with how much oil different nations import or produce. Our economic vulnerability to oil price shocks

is entirely a function of how much oil we use—the continent from which the oil was extracted has no bearing whatsoever on this equation.

Moreover, as members of this committee know better than anyone else, some of the most profound consequences of America's dependence on oil go well beyond the economic. It's virtually impossible to put a dollar figure on all the costs of that dependence, but there is no question that our thirst for oil constrains our foreign policy, imposes burdens on our military, accounts for approximately for one-third of the U.S. current account deficit which soared to $805 billion in 2005, swells the coffers of undemocratic and even actively hostile governments, and directly or indirectly provides some of the funding for terrorist organizations that mean us harm. These risks and vulnerabilities too, like those we face strictly in terms of our own economic well-being, will surely continue to grow if we don't take action. Put simply, if current trends don't change we face a global scramble for energy resources within this century that is sure to be economically and geopolitically damaging to all concerned.

Confronted with these realities it is tempting—but wrong—to imagine that if we could only become energy self-sufficient everything would be fine. I can't underscore this point too strongly: energy "independence" must not be confused with energy "security." Energy independence is simply unrealistic and has been ever since President Nixon first proposed to enshrine it as a national goal in the 1970s. U.S. oil imports have been rising inexorably ever since. The United States alone currently accounts for fully one-quarter of world oil demand. What may be less well known is that we are also the world's third largest oil producer at present. But this will not last forever. Our nation holds less than 3 percent of the world's proved oil reserves. Sixty-one percent of world reserves, by contrast, are located in the Middle East.

World's Proved Oil Reserve*

Region	Percent of World's Proved Reserves
Middle East	61.7
Europe/Eurasia	11.7
Africa	9.4
South & Central America	8.5
North America	5.1
Asia Pacific	3.5

* = Only 9% of world reserves are held by countries considered ''free'' by Freedom House.

Current projections indicate that oil production by the United States and other industrialized countries will decline by 6 percent over the next two decades, even as oil production in the former Soviet Union increases by nearly 50 percent and OPEC output increases 33 percent. This means that U.S. oil imports will continue to grow in the future, as they have for the last several decades, and that we like everyone else will increasingly need to rely on oil sup-

plies that originate in what are now unstable and undemocratic regions of the world. Nor will our dependence on foreign sources of energy be limited to oil: given declining domestic production of natural gas—another fuel that plays an extremely important role in the U.S. economy—it appears inevitable that we will increasingly need to rely on overseas sources for natural gas as well. The key, then, to greater energy security for the United States lies in recognizing—and better managing—our fundamental energy interdependence.

Oil Market Fundamentals

Nearly all experts agree about the fundamental drivers behind today's high oil prices and extreme market volatility. For some time now, rising global demand for petroleum—driven not only by growing U.S. demand, but in part by the very rapid modernization of countries like China and India—has been outpacing the discovery and development of new sources of supply. The result is that we now live in a world that requires approximately 85 million barrels of oil daily, but has only very little spare production capacity (as little as 2 percent, according to various estimates) and barely sufficient refining capacity. In this environment even small disruptions along the supply chain can cause serious repercussions. The dynamics are further strained by OPEC's ability to manipulate production quotas and by the participation of market players that operate on motives outside the bounds of economic efficiency. Unfortunately, this set of conditions seems unlikely to change soon. U.S. and total world demand for oil are expected to increase substantially over the next 20 years. Between 2004 and 2025, U.S. demand is projected to grow 24 percent (from 21 to 26 million barrels per day) and total world demand is expected to increase 34 percent (from 82 to 110 million barrels per day). (In the last year, the U.S. Energy Information Agency has downgraded its 20-year domestic demand projection by 3 million barrels a day based on expectations that high global prices are here to stay.) The world is suffering from what can best be described as a "demand shock" as China, India, and much of the developing world, modernize their economies and dramatically increase their use of motor vehicles. Equally concerning, there is currently very little spare capacity in the global oil market to make up any shortfall in oil supplies that arises as a result of political instability, unforeseen demand growth, acts of terrorism, or weather-related events. In 2005, global spare production capacity totaled approximately 1.5–2.0 million barrels per day; by contrast spare production capacity in 2001 was approximately 7.3 million barrels per day. This means that any event that prevents even a relatively small amount of oil from reaching today's global markets can have a dramatic impact on prices.

In partnership with the organization, Securing America's Energy Future (SAFE), NCEP has been exploring the potential consequences of today's tight supply margins by examining the impacts of any number of possible disruptions in global oil supply. With help from industry and military experts, as well as from the Wall Street analysis firm Sanford C. Bernstein and Co. LLC, we concluded that any number of truly unexceptional circumstances could cause global oil prices to literally sky rocket. As part of an

oil crisis simulation called Oil ShockWave, we found that a mere 4-percent shortfall in daily world oil supplies could lead to a 177-percent increase in world prices. It wouldn't take much, in other words, to send oil prices even higher—perhaps significantly higher—than they already are. With the U.S. transportation system over 97 percent reliant upon petroleum, the impacts of such an increase could be devastating. As then Chairman of the Federal Reserve Alan Greenspan observed in 2002, "All economic downturns in the United States since 1973 have been preceded by sharp increases in the price of oil."

A Better Goal for Oil Security

If we accept that the key measure of our energy security is not how much oil we import, but how much our economy depends on oil, we can begin to articulate more realistic goals and actually set about achieving them. In fact, the oil intensity of the U.S. economy, as measured by gallons consumed per dollar of GDP generated, was cut in half between 1975 and 2000. There were multiple reasons for this decline and they are worth reviewing as we explore our policy options for the future. First, there were structural shifts in the U.S. economy that led to reduced oil consumption, including a shift to less energy-intensive enterprises generally, together with more efficient oil use in some industries and a shift away from oil to different fuels altogether in other industries, notably in the electric power sector. Second, and very important, were vehicle fuel economy standards introduced in the late 1970s that doubled the average mileage of our passenger car and light-duty fleet.

An ambitious goal is to cut the oil intensity of the U.S. economy in half again over 20 years. To achieve this goal would require roughly a 7.25 million barrel per day reduction in oil consumption by 2025. Unfortunately, progress in further reducing the overall oil intensity of the American economy has slowed in recent years, while progress in improving the efficiency of the nation's vehicle fleet has stalled altogether. But for a modest recent increase in light-truck standards, fuel economy requirements for passenger vehicles have been essentially unchanged since 1980. As a result, average fleet efficiency actually began to decline in recent years as large trucks and SUVs captured ever larger shares of the U.S. auto market. Simply stated, the United States will not have a serious policy to increase oil security until we achieve a significant increase in the fuel economy of our vehicles.

A fundamental premise underlying the Commission's oil security recommendations is the belief that we can neither drill nor conserve our way to energy security. We simply must address both the supply and demand sides of the equation if we are to have any hope of lasting success. As Congress and ordinary Americans search for solutions to the current costs of gasoline, it is painfully clear that there are no good near-term options. We must accept this unfortunate reality and direct our attention to minimizing the harmful effects of the oil shocks that are likely to occur with increasing regularity and severity over the next 20 years.

Solutions

As noted at the outset, the Commission believes that there are three essential elements to enhanced oil security: Increasing supply, reducing demand, and developing alternatives. The first two of these imperatives can be seen as buying us time to achieve the more fundamental benefits of a diversified portfolio of transportation fuels. We must seek to widen the gap between available supply and demand in the short- to medium-term as a means of calming today's extremely volatile markets and putting downward pressure on prices, even as we begin developing clean and affordable alternatives for the long-term. The Commission's specific recommendations for widening the gap on the supply side include:

1. Expanding and diversifying conventional supplies of oil, both at home and abroad;

2. Expanding the global network of strategic petroleum reserves; and

3. Exploring technologies and processes that would allow for the use of unconventional oil resources in a manner that is compatible with climate change and other environmental concerns.

On the demand side, the Commission recommends:

1. Significantly strengthening fuel economy standards for new passenger vehicles, while simultaneously reforming the existing CAFE program to reduce compliance costs and provide cost-certainty for manufacturers and consumers;

2. Creating incentives to accelerate the market penetration of highly efficient hybrid vehicles while also helping the domestic auto industry retool to meet growing demand for these vehicles; and

3. Exploiting opportunities to boost the efficiency of heavy-duty vehicles and to improve the fuel-economy performance of the existing light-duty vehicle fleet.

Finally, to develop long-term alternatives to petroleum, the Commission recommends a sustained and vigorous effort to spur public and private sector investment in the development and early deployment of domestically produced transportation fuels derived from biomass and organic wastes. Of all available alternatives to petroleum fuels, the Commission believes that cellulosic ethanol holds the most potential for displacing a significant fraction of transportation oil demand within the next 20–30 years and should therefore be a focus of near-term RD&D activities.

A summary of the potential benefits of supply and demand measures can be found at Appendix A.

Oil Supply Measures

The Commission believes that opportunities exist to substantially boost global oil production within the next 10 to 20 years. This would help to relieve upward price pressures and reduce the risk of significant supply disruptions over the same timeframe.

Domestic Production: The United States is currently the third largest oil-producing nation after Saudi Arabia and Russia. As

such, U.S. production clearly has a significant impact on the stability of the global oil market and efforts to expand production within our own borders must be pursued. Currently, the United States produces about 8.5 million barrels per day of oil (crude and products) and consumes about 21 million barrels per day of finished oil products. Domestic oil production is important to the nation's economy—it remains an important source of jobs and tax revenues in some regions of the country—and it offers the important advantage of reducing financial transfers to foreign nations. Although domestic production has generally declined over the past decade, it is now projected to increase modestly in the near term (1 million barrels per day in 2016) and to resume a gradual decline thereafter.

The United States is thought to have about 25 billion barrels of proved, conventional oil reserves, the great majority in Alaska and off our Pacific Coast with a smaller fraction off the Atlantic Coast and the eastern Gulf of Mexico.

U.S. Proved Conventional Oil Reserves

Conventional Reserves	Crude Oil (billions of barrels)
Alaska (ANWR)	10.36
Pacific Offshore	10.71
Eastern Gulf of Mexico	3.58
Atlantic Offshore	2.31

Though technically recoverable, much of this oil is currently off-limits to leasing. If all of it were tapped, it is estimated that U.S. oil output could be increased by about 2 million barrels per day in 2020. Obviously, many issues must be considered in weighing whether it is appropriate to open a particular area to oil drilling and the Commission takes no position on whether the status of specific regions that are currently off-limits should be changed. To provide a sound basis for future decision-making, however, the Commission does believe that an inventory of domestic petroleum reserves should be undertaken as part of a regular, comprehensive assessment of the nation's known and potential energy resources. Again, however, it cannot be stressed often enough that while U.S. production makes an important contribution to global supplies (and hence is critical to maintaining the near-term stability of global markets), our nation's economic vulnerability to oil price shocks is largely a function of how much oil we use and not how much we produce.

Global Production: Much more substantial oil reserves exist, of course, in other parts of the world, including—besides the Middle East—parts of the former Soviet Union, Africa, and South and Central America. The Commission therefore recommends that the U.S. Government encourage nations with significant underdeveloped oil reserves to allow foreign investment in their energy sectors to increase global oil production. Kazakhstan, for example, provides an example of the benefits of liberalized investment policies. Having opened its oil resources to significant foreign investment in the

mid-1990s, Kazakhstan's crude oil production rate more than doubled between 1996 and 2002. Output from this one nation is now expected to reach 2 million barrels per day in the next few years and could peak at as much as 4 million barrels per day further down the road. The Commission also recommends that the U.S. Government consider impacts on world oil markets in cases where unilateral economic sanctions imposed by our nation may be limiting investment in foreign energy markets without necessarily achieving their stated policy objectives.

Unconventional Oil Supplies: Accounting for unconventional oil supplies—such as tar sands in Canada, heavy oil in Venezuela, and oil shale in the United States—would significantly shift the hemispheric balance of world petroleum resources. With today's high prices, these unconventional resources are already being tapped to a greater extent and by 2015 it is likely that Canada and Venezuela together will produce nearly 3.5 million barrels per day of unconventional crude. At the same time, the Fischer-Tropf process, which has been used for over 50 years to convert coal into a form of clean diesel fuel, could—at prices above $50 per barrel— become a significant source of domestic transportation fuel.

Further reliance on unconventional oil resources in the future, however, will require substantial progress toward reducing the substantial energy requirements and negative environmental impacts currently associated with extracting and processing them. Absent efforts to sequester the carbon used in producing unconventional oil, for example, the total greenhouse gas emissions associated with these resources are roughly two and a half times greater than the emissions associated with conventional oil production. While the Commission does not believe that our nation's oil policy must be viewed as a vehicle for achieving its climate protection objectives, it seems equally clear to us that it would be foolhardy to pursue an oil policy that is at odds with other compelling public policy objectives. Unless and until we learn how to develop these resources without significantly increasing greenhouse gas emissions, the Commission believes that exploiting unconventional oil reserves does not offer a viable long-term pathway toward a more secure energy future. Therefore, the Commission has recommended increased funding to improve the environmental performance of technologies and practices used to produce unconventional oil resources.

Strategic Reserves: Oil stockpiles provide an important insurance policy against the potentially dire consequences of a significant short-term global supply disruption. Combined with private stocks, the U.S. Strategic Petroleum Reserve currently provides us with enough spare capacity to cover the loss of all imports for approximately 150 days, or a partial disruption for much longer. To improve global and domestic oil security, the Commission recommends that the U.S. Government work with other major oil-consuming nations to increase their public reserves and participate in the global network of strategic reserves.

In particular, membership in the International Energy Agency (IEA) could provide major emerging oil-consuming nations like China and India with: (1) A greater feeling of ownership on their

part in how the "global energy system" is run; (2) improved transparency in energy statistics and policymaking; and (3) an established forum to communicate concerns, success stories, and partnership ideas. IEA membership also brings with it a requirement that nations maintain strategic oil stocks sufficient to supply 90 days of demand and agree to manage them in coordination with IEA member countries (although this requirement is not legally binding). Because the IEA is a cooperative group of the Organization for Economic Cooperation and Development (OECD)—the IEA's 26 member nations include most OECD countries—a number of issues would have to be addressed with respect to the inclusion of currently non-OECD developing nations. In the past, initiation into the OECD has been a lengthy and sometimes controversial process in which standards of economic development, openness, and human rights are considered. Given the potential benefits noted above, however, possibilities for bringing countries like China or India into the IEA on an expedited or alternative basis—perhaps with special observer or some other unique status—should be explored.

Oil Demand Measures

While the Commission firmly believes that both supply and demand measures must be pursued as part of an effective strategy to enhance the nation's energy security, it is important to emphasize that when it comes to protecting the economy from oil price shocks, a barrel produced and a barrel conserved are not the same thing. The benefits of every added barrel of supply—whether produced domestically or abroad—accrue to oil consumers the world over, in the form of a marginal reduction in the market price. By contrast, the benefits that can be achieved through demand-side measures and alternative fuel production—besides being much larger in absolute magnitude—are largely captured by those who implement them. The Commission therefore devoted significant attention to the potential for reducing our nation's oil demand, particularly in the transportation sector, which—because it accounts for nearly 70 percent of current domestic consumption and is nearly solely dependent on petroleum fuels—is key to oil use in the broader U.S. economy.

Strengthening and Reforming CAFE While Promoting Advanced-Technology Vehicles and Addressing Jobs and Competitiveness Concerns: Improving passenger vehicle fuel economy is by far the most significant and reliable oil demand reduction measure available to U.S. policymakers. As noted previously, CAFE standards played an important role in substantially reducing the oil intensity of the U.S. economy between the late 1970s and early 1990s. However, a longstanding political stalemate has blocked significant progress in fuel economy for over two decades. People often confuse our failure to increase domestic fuel economy with the view that technology options for improving vehicle efficiency have not advanced over the past two decades. Nothing could be farther from the truth. The efficiency of our automobiles increases annually. Estimates of this annual increase vary substantially from a low estimate of roughly 1.5 percent per year to a high estimate of over 5 percent per year. However, absent any requirement to direct these substantial effi-

ciency gains toward achieving the public good of reduced oil dependence, vehicle manufacturers have instead devoted recent technological advancements to simply maintaining fuel economy while dramatically increasing vehicle size and power. While vehicle fuel economy is now no higher than it was in 1981, vehicle weight has increased by 24 percent and horsepower has increased by over 100 percent over this same time period. In fact, most of today's economy cars outperform the "muscle" cars of the 1970s. If we enhance the rate of efficiency advancement and channel the majority of this improvement into greater fuel economy, we can maintain the amenities of the current vehicle fleet while gradually increasing fuel economy every year.

In proposing to significantly strengthen and reform vehicle fuel economy requirements, the Commission sought to address the three issues we believe are most responsible for the last two decades of stagnation in this critical policy area: (1) Uncertainty over the cost of future fuel-saving technology; (2) concern that more stringent standards will compromise vehicle safety; and (3) fears that new standards will put the U.S. auto industry and U.S. auto workers at further competitive risk relative to foreign automakers.

CAFE Reform: Pairing a significant increase in standards with reforms that would make the CAFE program more flexible and reduce the compliance burden for manufacturers would help to address cost concerns. The Commission commends recent efforts by the National Highway Traffic Safety Administration (NHTSA) to introduce program reforms as part of its 2005 rulemaking to update CAFE standards for light trucks. Further reforms that should be considered include allowing manufacturers to trade fuel economy credits with each other and across the light truck and passenger vehicle fleets, as well as "safety valve" mechanisms that would set a defined upper limit on compliance costs in the event that fuel-savings do not mature as expected or prove more expensive than anticipated.

The adequacy of NHTSA's authority to craft effective CAFE standards for passenger cars has recently been called into question. The Commission believes that NHTSA should be granted the requested authority and similarly that Congress should provide NHTSA with clear direction about how to apply it. When NHTSA sets new standards, the Agency seeks to fully offset the costs of new fuel-saving technology with the value of saved gasoline. This approach has obvious merit, but its application depends significantly upon NHTSA's ability to assess the full societal benefits of avoiding a gallon of gasoline consumption. At present, NHTSA lacks both the tools and authority to adequately factor in many of these broader externalities. This inability results in a systematic undervaluation of the benefits achievable through improved vehicle fuel economy and results in standards that are lower than would be justified by a more comprehensive assessment. It's not that NHTSA doesn't work hard to assess these externalities—in its recent light truck rulemaking, the Agency sought to include factors such as reduced vulnerability to oil price shocks, reduced air pollution, and even the value of spending less time at gas stations.

However, NHTSA has no ability to quantify the value of reduced future tensions with China over tight oil supplies or the constraints

that oil dependence imposes on our foreign policy. After considering the costs of protecting our access to global oil resources, NHTSA, in its recent rulemaking, decided not to include any value in reduced military costs as a result of increased fuel economy. The Regulatory Impacts Assessment reads:

> *The U.S. military presence in world regions that represent vital sources of oil imports also serves a range of security and foreign policy objectives that is considerably broader than simply protecting oil supplies. As a consequence, no savings in government outlays for maintaining the Strategic Petroleum Reserve or a U.S. military presence are included among the benefits of the light truck CAFE standard adopted for MY 2008–2011.*

All told, NHTSA's recent rulemaking assesses total petroleum market externalities to be slightly less than 6 cents per gallon. When added to projected gasoline costs of $1.60 per gallon over the next decade ($2 pump price minus roughly $.40 in taxes), NHTSA arrives at a total societal value of a gallon of gasoline saved at just under $1.70 gallon. This number clearly helps explain why the increase in truck standards that emerged from the rulemaking process was so modest.

When considering the administration's recent request that Congress grant NHTSA broad authority to reform passenger car standards along the same lines as the recent light-truck rulemaking, Congress must also consider giving the agency specific, updated guidance about the factors to be considered in establishing standards and about how these factors should be weighted and analyzed. Moreover, given the apparent political difficulty of revisiting fuel economy regulations, Congress should also consider establishing—or directing NHTSA to establish—a dynamic fuel economy target that becomes gradually but steadily more aggressive over time, rather than picking a single number. A defined percent-per-year improvement goal, coupled with an effective cost-capping mechanism or well-defined "off-ramps" in the event that later requirements begin to impose unacceptable tradeoffs in terms of cost or other vehicle attributes, may prove more effective over time and more palatable in the short run, than choosing a particular mpg requirement that remains fixed for years or even decades.

Vehicle Safety: Safety concerns have long contributed to the prevailing CAFE stalemate, but there is reason for optimism that the terms of this debate, too, have begun to shift in important ways. First, the rapid emergence of hybrid-electric vehicle technology clearly demonstrates that substantial fuel economy improvements can be achieved while maintaining or even increasing horsepower and without reductions in vehicle weight or size. Second, a more sophisticated approach to the issue of safety—one that accounts for the impact of heavier vehicles on other vehicles in the event of a collision and their effects on overall fleet safety as well as on the safety of their individual occupants—has served to illuminate the fact that while the relationship between vehicle weight and safety is clearly important, it is far from straightforward. Finally, some argue that advances in light but very strong composite materials that allow for significant weight reductions to be achieved in con-

cert with ongoing safety improvements—together with other advances in vehicle design and safety features—will prove fundamentally game-changing, although for now cost issues remain.

Domestic Industry Competitiveness: Given the recent, well-publicized troubles of U.S. automakers, concerns about jobs and competitiveness will continue to figure prominently in any debate over vehicle fuel economy. The Commission worked with the United Auto Workers and experts at the University of Michigan to assess the competitive impacts of a significant increase in fuel-economy requirements on the domestic automobile industry. Our analysis suggests that the domestic automakers currently are at a disadvantage, relative to their foreign competitors, in terms of the expertise and manufacturing capacity needed to design, produce, and incorporate the most advanced hybrid-electric and diesel technologies. Therefore the Commission urges policymakers to consider mechanisms for addressing jobs and competitiveness concerns that would strengthen the domestic industry and better position it to meet future global demand for advanced technology vehicles. Specifically, the Commission recommended in its 2004 report that consumer tax incentives to stimulate consumer demand for highly efficient, advanced-technology vehicles be extended and coupled with business tax incentives aimed at helping parts suppliers and manufacturers with U.S. facilities retool their plants to produce these vehicles. Importantly, the Commission's analysis showed that such incentives could be designed to ensure that their cost to the U.S. Treasury would be more than covered by the additional tax revenues associated with increased domestic production. In light of the fact that domestic manufacturers are presently losing money and hence not paying much in the way of taxes, additional work is underway to design alternative mechanisms to provide the suggested incentives.

Oil Savings through Increased Fuel Economy: The oil savings achievable through improved new vehicle fuel economy depend, of course, on specific assumptions about how quickly and aggressively new standards would be introduced and on whether other aspects of the current CAFE program are reformed at the same time. Appendix A summarizes the results of a bounding exercise intended to portray the savings that could be achieved if new vehicles technologies were employed to increase fuel economy over the next 20 years. The results are cumulative (that is, each row includes the demand reductions associated with all of the rows above it) and reflect oil savings in 2025 from a baseline business-as-usual demand forecast of 26 million barrels per day. The table suggests that the United States could reduce oil consumption in 2025 by 2.2 million barrels per day by implementing a 40-percent improvement in gasoline vehicle efficiency. If a significant fraction of fuel-efficient hybrid vehicles were added to the mix, the savings would rise to roughly 3.5 million barrels per day. Under the most aggressive scenario considered, U.S. oil consumption could be reduced by nearly 5 million barrels per day if the new-vehicle fleet in 2025 were comprised of a combination of efficient gasoline, gasoline hybrid and plug in hybrid vehicles.

Fuel Economy Improvements in the Heavy-Duty Truck Fleet and Existing Light Vehicle Fleet: Smaller but nonetheless important op-

portunities exist to reduce U.S. oil consumption by improving the fuel economy of the heavy-duty truck fleet and of the existing light-car fleet. The Department of Energy's 21st Century Truck Program, for example, is being undertaken with the cooperation of major heavy-truck engine manufactures; it estimates that the fuel economy performance of so-called "Class 8" long-haul trucks, which are the largest fuel consumers of all heavy trucks, could be improved as much as 60 percent. Enhanced diesel technology and improved aerodynamics in the heavy-duty truck fleet could produce oil savings of as much as 1 million barrels per day in 2025. As an initial step, the Commission recommends that EPA be instructed to develop a test procedure to assess heavy-duty vehicle fuel economy so that we have an opportunity to seek reductions from this sector should the will to do so emerge in the future. For the existing light-duty vehicle fleet, simply ensuring that replacement tires have the same low rolling resistance as original-equipment tires can improve vehicle fuel economy by as much as 4.5 percent at very low cost to the vehicle owner.

Efficiency improvements are important not only because they produce demand reductions that will allow us to "buy time" to develop new alternatives to oil (a serious effort to diversify our fuel supply will likely take decades), but because they are essential to making many of those alternatives technologically and economically viable on a commercial scale. Biofuels and most other alternative fuels suffer from feedstock constraints, a lower energy density than gasoline, or both. Unless the vehicle fleet becomes more fuel-efficient, efforts to promote a greater reliance on alternative fuels will likely falter due to inadequate supply or inadequate driving range. Conversely, the land requirements for cellulosic ethanol production or the battery requirements for a plug-in hybrid-electric vehicle become much more manageable if the vehicles that employ these fuels or technologies are also highly efficient to begin with. Once one recognizes that the successful development of petroleum alternatives depends on highly efficient vehicle technologies, it becomes apparent that current provisions intended to promote the production of flexible-fueled vehicles by providing credits that weaken overall fleet fuel economy are shortsighted and ultimately counterproductive.

Developing Alternatives to Oil

The United States burns nearly 140 billion gallons of gasoline each year and relies on petroleum-based fuels to supply nearly all of its transportation energy needs. To meaningfully improve our nation's energy security, alternative transportation fuels must be capable of being economically and reliably produced on a truly massive scale. The Commission identified four criteria that characterize a promising alternative fuel: (1) It can be produced from ample domestic feedstocks; (2) it has low net, full fuel-cycle carbon emissions; (3) it can work in existing vehicles and with existing infrastructure; and (4) it has the potential to become cost-competitive with petroleum fuels given sufficient time and resources dedicated to technology development. Among the variety of alternative fuel options potentially available for the light-duty vehicle fleet, the Commission believes that ethanol produced from cellulosic biomass

(i.e., fibrous or woody plant materials) should be the focus of near-term federal research, development, and commercial deployment efforts. Let me briefly discuss the attributes of traditional corn-based ethanol and then turn to cellulosic ethanol.

Corn-based ethanol is far and away our most successful non-petroleum transportation fuel. The Renewable Fuels Standard adopted in the 2005 Energy Policy Act imposes an annual ethanol sales requirement that grows to 7.5 billion gallons in 2012. Ethanol sales were roughly 4 billion gallons last year. Despite the beneficial sales-volume credits given to producers of cellulosic ethanol, virtually all of this mandate will be met with traditional corn ethanol. A requirement to sell 250 million gallons of cellulosic ethanol takes effect in 2013. To an extent, Congress's effort to stimulate demand for cellulosic ethanol may be undermined by the unexpected demand for ethanol of any kind. Present expectations are that demand for ethanol will exceed the requirements of the RFS for most if not all of the program. In this context, credits may have little or no value and the 2.5:1 cellulosic credit advantage may provide no meaningful benefit. Congress may want to investigate other policy approaches to achieve the intended aims of these credit provisions.

For years, detractors of corn-based ethanol have asserted that the energy content of a gallon of ethanol is matched or even exceeded by the energy required to produce it. The Commission's analysis disputes this conclusion, finding that corn-based ethanol provides nearly 20 percent more energy than it takes to produce. A more recent study by Argonne National Laboratory finds nearly a 35-percent benefit. Nevertheless, the fundamental liability of corn-based ethanol is that there is simply not enough corn to begin to keep pace with expected growth in transportation energy demand, let alone to reduce current U.S. gasoline consumption in absolute terms. Put simply, it takes roughly 4 percent of our nation's corn supply to displace 1 percent of our gasoline supply. Even organizations devoted to ethanol advocacy agree that it will be difficult to produce more than 10–12 billion gallons of ethanol a year without imposing unacceptable demands on corn supply and significant upward pressure on livestock feed prices.

Cellulosic ethanol is chemically identical to corn-based ethanol and is equally compatible with existing vehicle technology and fueling infrastructure. The added advantages of cellulosic ethanol lie in its significantly lower energy inputs and greenhouse gas emissions, its much larger base of potential feedstocks, and its greater potential to become cost-competitive with gasoline at very large production volumes. For cellulosic ethanol to succeed on a commercial scale, however, important concerns about land requirements must be overcome and production costs must be reduced. The central challenge is producing enough feedstocks without disrupting current production of food and forest products. Some cellulosic ethanol can be produced from currently available waste products such as corn stalks, sugar cane bagasse, and wheat straw. Production volumes on the order of 50 billion gallons per year, however, will require improved high-yield energy crops like switchgrass, the integration of cellulosic ethanol production into existing farming activities, and efficiency improvements in the processes used to convert cellulosic materials into ethanol.

A Commission-sponsored analysis of the land required to produce enough cellulosic ethanol to fuel half of the current U.S. passenger vehicle fleet reveals the importance of the advancements noted above. Using status quo assumptions for crop yields, conversion efficiency, and vehicle fuel economy, Oak Ridge National Laboratory has estimated that it would take 180 million acres or roughly 40 percent of the land already in cultivation in the United States to fuel half the current vehicle fleet with cellulosic ethanol. Estimated land requirements can be reduced dramatically—to approximately 30 million acres—if one assumes steady but unremarkable progress over the next two to three decades to (1) double per-acre yields of switchgrass, (2) increase the conversion efficiency of ethanol production by one-third, and (3) double the fuel economy of our vehicle fleet. As a point of reference, there are roughly 30 million acres in the Conservation Reserve Program (CRP).

Another central challenge is reducing production costs for cellulosic ethanol. Because energy crops like switchgrass can be grown with minimal inputs of energy, fertilizer, and pesticides, the use of such feedstocks offers obvious economic benefits, as does producing ethanol from materials that would otherwise be treated as waste. The National Renewable Energy Laboratory and a separate analysis sponsored by the Commission both suggest that mature cellulosic ethanol production could compete economically with gasoline. However, these studies are projections. At this time, no full-scale production of cellulosic ethanol exists anywhere in the world. Until cellulosic ethanol is produced in a variety of commercial facilities, it will not be possible to prove or disprove current cost estimates. These are serious challenges, but they are achievable if we dedicate ourselves to a serious, coordinated, and sustained research, development, and commercialization effort.

As a critical first step in this direction, the Energy Policy Act of 2005 contains at least 10 major programs to promote ethanol derived from cellulosic feedstocks. These programs include explicit authorizations for more than $4.2 billion over the next decade to support critical R&D as well as "first-mover" commercial facilities through a combination of grants, loan guarantees, and production incentives. While these programs demonstrate Congress's clear intention to promote biofuels, continued vigilance will be required to ensure that this vision is achieved. Historically, efforts to promote biofuels have been undermined by a lack of appropriations, inconsistent funding year to year, and an unusual degree of congressional earmarks. These factors, if continued, will make it difficult to achieve the critical objective of diversifying our nation's fuel supply.

The 2005 Energy Policy Act also took steps to ensure that increased use of ethanol will not undermine air quality and public health standards. Eliminating the opportunity for ethanol-blended gasoline to meet less protective evaporative emission standards remains necessary to ensure that our efforts to increase energy security do not undermine our clean air goals. Finally, carmakers will need to take some steps to better accommodate ethanol-blended gasoline. The Coordinated Research Council, which is supported by the automotive and petroleum industries and the State of California, has been conducting research to examine the extent to

which automobile evaporative emissions increase in cars using ethanol-blended fuels. The research appears to indicate that when a small quantity of ethanol is blended into gasoline, the resulting mixture escapes more readily through the hoses and seals in the vehicle's fuel system leading to more smog-forming emissions. The problem appears less prevalent in newer vehicles but demonstrates the type of challenges that will arise as we begin to transition toward a more diverse suite of transportation fuels. One of the many reasons for interest in promoting flexible-fueled vehicles capable of running on up to 85 percent ethanol blends is that when ethanol is the dominant constituent, the overall volatility of the fuel is reduced and evaporative problems go away. Efforts by Chairman Lugar, Senator Obama, and others to increase the number of flexible-fueled vehicles sold over the next decade and significantly increase ethanol refueling infrastructure deserve serious consideration.

In sum, the Commission urges Congress to make every effort to fund the research and demonstration projects authorized in the Energy Policy Act of 2005. While it is clear that all discretionary programs must come under continual budget scrutiny, inconsistent funding from year to year can be devastating to long-term research efforts by making it impossible to hire and train experts, build infrastructure, and amass knowledge based on iterative experimentation. The Commission recognizes that Congress alone is responsible for appropriations, but can't help but note that the high level of noncompetitive earmarks is undermining the strategic goals of our nation's bioenergy programs. For example, in 2004, of the $94 million in appropriations for DOE's bioenergy programs, nearly $41 million was directed to earmarked projects. In 2005, earmarks accounted for nearly 50 percent of the program's budget. Paradoxically, this high level of earmarks reflects the enthusiasm of many Members of Congress for promoting domestic alternatives to petroleum. However, an effective national effort that coordinates the efforts of Federal, State, and private institutions cannot be mounted under these circumstances.

Conclusion

Sadly, there are no good options for delivering immediate relief from high prices at the gas pump. And while it's understandable at times like this that people want to focus on price gouging, windfall-profits, or restrictive environmental laws—as if our plight was somehow the result of a few greedy people or poorly written statutes—we must direct the vast majority of our attention to confronting the fundamental roots of our oil security predicament. To make real progress, we must substitute thoughtful analysis for rhetoric and rise above the temptation to take political advantage of the current crisis by crafting a truly bipartisan response.

Prices may, of course, fall again in the months ahead. But there is almost no scenario in which the underlying causes of the current crisis simply resolve themselves without a concerted effort by the United States and other major oil-consuming nations to change course. The real tragedy would be if this "moment" simply passes as others have with no real progress toward a lasting solution. In short, there is no question that we will someday use less oil than

we do now. The question is rather whether we arrive at that point on our own terms or on someone else's. The Commission believes that the sacrifices we choose are infinitely preferable to those imposed on us by forces we cannot control. The National Commission on Energy Policy looks forward to working with this committee in its ongoing effort to chart a more secure energy future for our nation.

APPENDIX A

Summary of Measures for Improving U.S. Oil Supply

	Measure	Projected Impact/Projected Oil Savings
Increasing Supply		
	Exploit all domestic conventional reserves	Increase U.S. output by 2.0 MBD
	Exploit global reserves ofunconventional oil	Increase global supply by 4.0+ MBD
Reducing Demand		
Heavy Duty Trucks		
	Enhanced Diesel Technology and Aerodynamics	1.0 MBD
	Reduce Average Highway Speed by 10 mph	0.3 MBD
Passenger Vehicles and Delivery Trucks		
	Advanced Gasoline Engine Technology (32 mpg)	2.2 MBD
	Advance Gasoline Engine Technology + 50% Advanced Hybrid/Diesel Sales (40 mpg)	3.5 MBD
	Advanced Gasoline Engine Technology + Advanced Hybrid/Diesel + 25% Plug-in Hybrids (50 mpg)	4.6 MBD
DevelopingAlternative Fuels		
	Quadruple ethanol production post-2012	2.0 MBD (30 billion gallons)
	Dramatically increase biodiesel production	0.5 to 1.0 MBD (7.5 to 15 billion gallons)

Summary of Measures for Improving U.S. Oil Supply—Continued

	Measure	Projected Impact/Projected Oil Savings
	Create Domestic Fischer-Tropsch Industry (Coal to Diesel)	0.5 to 3.0+ MBD (7.5 to 45+ billion gallons)

"THE HIDDEN COST OF OIL"

Thursday, March 30, 2006

OPENING STATEMENT

HON. RICHARD G. LUGAR

U.S. SENATOR FROM INDIANA,
CHAIRMAN, SENATE COMMITTEE ON FOREIGN RELATIONS

The Foreign Relations Committee meets today to consider the externality costs of U.S. dependence on fossil fuels. The gasoline price spikes following the Katrina and Rita hurricanes underscored for Americans the tenuousness of short-term energy supplies. Since these events, there is a broader understanding that gasoline and home heating prices are volatile and can rapidly spike to economically damaging levels due to natural disasters, terrorist attacks, or other world events. But, as yet, there is not a full appreciation of the hidden costs of oil dependence to our economy, our national security, our environment, and our broader international goals.

Today, with the help of experts who have thought a great deal about these issues, we will attempt to more clearly define some of these costs. We are cognizant that this is a difficult and imprecise exercise. We are also aware that most, if not all, energy alternatives have some externality costs. But we are starting from the presumption that if we blithely ignore our dependence on foreign oil, we are inviting an economic and national security disaster.

With less than 5 percent of the world's population, the United States consumes 25 percent of its oil. If oil prices remain around $60 a barrel through 2006, we will spend approximately $320 billion on oil imports this year. Most of the world's oil is concentrated in places that are either hostile to American interests or vulnerable to political upheaval and terrorism. More than three-quarters of the world's oil reserves are controlled by national oil companies. And within 25 years, the world will need 50 percent more energy than it does now.

These basic facts demand a major reorientation in U.S. policy aimed at reducing U.S. dependence on fossil fuels. Our goals must be to mitigate the short-term costs of our dependence on oil, while pursuing energy alternatives that would reduce the international leverage of petro-superpowers, improve environmental quality, cushion potential oil price shocks, stimulate new high-tech energy industries, and ground the American economy on energy sources that will neither run out nor be cut off by a foreign supplier.

There are at least six basic threats associated with our dependence on fossil fuels. First, oil supplies are vulnerable to natural disasters, wars, and terrorist attacks that can produce price shocks and threats to national economies. This threat results in price instability and forces us to spend billions of dollars defending critical fossil fuel infrastructure and choke points.

Second, over time, finite fossil fuel reserves will be stressed by the rising demand caused by explosive economic growth in China, India, and many other nations. This is creating unprecedented competition for oil and natural gas supplies that drives up prices and widens our trade deficit. Maintaining fossil fuel supplies will require trillions in new investment—much of it in unpredictable countries that are not governed by democracy and market forces.

Third, energy rich nations are using oil and natural gas supplies as a weapon against energy poor nations. This threatens the international economy and increases the risk of regional instability and military conflict.

Fourth, even when energy is not used overtly as a weapon, energy imbalances are allowing oil-rich regimes to avoid democratic reforms and insulate themselves from international pressure and the aspirations of their own people. In many oil rich nations, oil wealth has done little for the people, while ensuring less reform, less democracy, fewer free market activities, and more enrichment of elites. It also means that the United States and other nations are transferring billions of dollars each year to some of the least accountable regimes in the world. Some of these governments are using this money to invest abroad in terrorism, instability, or demagogic appeals to anti-Western populism.

Fifth, reliance on fossil fuels contributes to environmental problems, including climate change. In the long run, this could bring drought, famine, disease, and mass migration, all of which could lead to conflict and instability.

Sixth, our efforts to facilitate international development are often undercut by the high costs of energy. Developing countries are more dependent on imported oil, their industries are more energy intensive, and they use energy less efficiently. Without a diversification of energy supplies that emphasizes environmentally friendly options that are abundant in most developing countries, the national incomes of energy poor nations will remain depressed, with negative consequences for stability, development, disease eradication, and terrorism.

Each of these threats comes with short- and long-term costs. As a result, the price of oil dependence for the United States is far greater than the price consumers pay at the pump. Some costs, particularly those affecting the environment and public health, are attributable to oil no matter its source. Others, such as the costs of military resources dedicated to preserving oil supplies, stem from our dependence on oil imports. But each dollar we spend on securing oil fields, borrowing money to pay for oil imports, or cleaning up an oil spill is an opportunity missed to invest in a sustainable energy future.

Certain types of costs are extremely difficult to quantify. We understand that many national security risks are heightened by our oil dependence. But how, for example, would we assign a dollar fig-

ure to Iran's use of its energy exports to weaken international resolve to stop its nuclear weapons program?

Yet we should do our best to quantify the externality costs of oil, so we have a clearer sense of the economic and foreign policy tradeoffs that our oil dependence imposes on us. As the U.S. Government and American businesses consider investments in energy alternatives, we must be able to compare the costs of these investments with the entire cost of oil. Public acknowledgement of the billions of dollars we spend to support what the President has called our "oil addiction," would shed new light on investment choices related to cellulosic ethanol, hybrid cars, alternative diesel, and other forms of energy.

As we address these questions today, we will have the benefit of a distinguished panel of experts. Dr. Hillard Huntington is executive director of the Energy Modeling Forum at Stanford University. He is a senior fellow and past president of the United States Association for Energy Economics. He recently coordinated two studies funded by the Department of Energy that evaluated the economic risks of oil price shocks. Mr. Milton Copulos is President of the National Defense Council Foundation. He has advised Secretaries of Defense, Energy, and Interior and was a member of the National Petroleum Council. He is widely published on military affairs and has devoted much study to the military expenditures associated with ensuring the flow of oil. Dr. Gary Yohe is the John E. Andrus Professor of Economics at Wesleyan University. Professor Yohe is widely published on the adaptation and mitigation of climate change. He recently edited Avoiding Dangerous Climate Change, the collection of papers on the subject that were prepared for last year's G–8 Summit.

We welcome our three witnesses and look forward to their insights.

OPENING STATEMENT

HON. JOSEPH R. BIDEN, JR.

U.S. SENATOR FROM DELAWARE,
RANKING MEMBER, SENATE COMMITTEE ON FOREIGN RELATIONS

Mr. Chairman, thank you for holding this hearing on the "Hidden Costs of Oil."

For most of us, the costs of oil seem far from hidden. They are right up there on the signs at our gas stations, they are there in black and white on our heating bills.

But as our witnesses will show us today, the price at the pump, the price on our heating bills, as bad as they may be, are only part of the story.

Those prices conceal the hidden tax we pay to OPEC countries who use their pricing power to charge us more than they could get in an open international market for oil.

In addition, those prices conceal the costs of the security commitments we face to protect the supply of oil from OPEC and other foreign sources.

And they conceal the costs to our foreign policy, which has been handcuffed for over half a century by our dependence on oil from parts of the world with very different interests from our own.

At the same time, the rising price of oil has created a cushion that props up despotic regimes and finances their militaries or allows other countries to put off hard decisions about democratic and economic reform.

Finally, the price at the pump hides the long-term environmental damage—as well as the economic and social disruptions—that will come with global warming.

The economic, social, political, and environmental costs we face today—and the costs of dealing with their repercussions in the future—will not stay hidden.

There is no free lunch, as economists never tire of telling us. Somebody eventually has to pick up the tab.

When we pay too much for oil—because OPEC can use its market power—we have less money for other priorities. That artificial inflation affects both domestic and imported oil, since there is essentially just one world market for oil.

In turn, we pay too much for transportation, and power. We pay too much for the plastics and other products derived from oil.

That is a dead-weight loss for the entire economy. Every watt of electricity from our power plants, every minute we run a refrigerator or air conditioner, every trip to the store, everything shipped by truck or rail—all those parts of our everyday lives costs more than they should.

That leaves us with less to spend on other priorities. It make us poorer—as individuals, as families, as a nation.

Mr. Chairman, we often speak about the costs of our foreign policy—usually we are speaking metaphorically. We may talk about trading values or prestige in one area to secure influence or leverage in another.But there are real costs to our policies, too, of course. As hard as they may be to calculate, we must try to measure the economic costs of our reliance on oil, especially on imported oil, on oil from countries that are themselves unstable or that promote instability.

That will be important testimony for the record of this committee, Mr. Chairman.

Throwing our net a little wider, Mr. Chairman, from the quantifiable costs of oil to our economy, and the costs of our foreign entanglements to secure that oil, we come to the costs we will incur to cope with the climate change that will result from our use of oil and other fossil fuels.

You and I share a concern about all of the foreign policy implications of climate change, Mr. Chairman. Climate change will alter growing seasons, redistribute natural resources, lift sea levels, and shift other fundamental building blocks of economic, social, and political arrangements around the world. It could spark massive human migrations and new wars over resources. We will pay a price for those, too.

No other issue carries such a threat to our way of life. Putting a dollar value on that threat can show us what we are risking if we don't act now to slow global warming.

In every one of the areas we will look at today, the near-term prospects are grim. The rise of the massive economies of China and India will continue to put pressure on supply, will demand tens of billions in investments, will further complicate global oil and energy politics, and will accelerate the accumulation of carbon dioxide and other greenhouse gases.

Half the world's population—3 billion people—live on $2 a day. Just to provide them with a little electricity to replace wood and kerosene for cooking, to pump water, to light a schoolhouse—will require more than our current energy system can provide.

To meet the inevitable challenges built into our current fossil fuel economy, we must first start with the facts. Today we will learn the many ways the true costs of oil are hidden from us.

To make clear choices, we need to have the right information. Hidden costs lead consumers to make the wrong choices. They distort investment decisions—we invest too much in systems that will make our problems worse, and we invest too little in solutions.

This hearing will give us some of the facts we need to start making the right choices.

Thank you, Mr. Chairman.

PREPARED STATEMENT

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BEFORE THE

U.S. SENATE COMMITTEE ON FOREIGN RELATIONS

MARCH 30, 2006

My name is Milton R. Copulos, and I am president of the National Defense Council Foundation.

I would like to thank Chairman Lugar for giving me the opportunity to speak with the committee today and I would also like to commend him for his leadership addressing our nation's perilous energy dependence.

A HEADLONG RUSH INTO DISASTER

America is rushing headlong into disaster. What is worse, however, is that it is a disaster of our own design.

More than three decades have passed since the 1973 Arab Oil Embargo first alerted the nation to its growing oil import vulnerability. Yet, despite this warning, we are now importing more than twice as much oil in absolute terms than we did in 1973, and the proportion of our oil supplies accounted for by imports is nearly double what is was then. What makes this dependence even more dangerous than it was three decades ago is the fact that the global market has become a far more competitive place with the emerging economies of China, India, and Eastern Europe creating burgeoning demand for increasingly scarce resources.

Indeed, over the past decade the Chinese economy has grown at a frenetic pace, officially estimated at 9.2 percent in 2005. India's growth rate for that year was 7.1 percent. In Eastern Europe, Belarus grew at 7.8 percent, the Czech Republic at 4.6 percent, and the Ukraine at 4.4 percent. This compares with 3.5 percent for the United States, 2.1 percent for Japan, and 1.7 percent for the European Union.

As a result of this explosive growth, oil consumption in the developing countries is expected to increase at a rate of 3 percent annually over the next two decades. But even this figure may severely understate the problem. Indeed, China alone has accounted for 40 percent of the total increase in world oil consumption over the past several years. Moreover China plans to add 120 million vehicles to its automobile fleet over the next decade, ultimately requiring 11.7 million barrels per day of new crude oil supplies. India, too, is ex-

pected to continue to require increasingly large amounts of oil with a projected increase of 28 percent over just the next 5 years.

Even conservative estimates suggest that nearly 30 million barrels per day of new oil supplies will be required by the year 2025 just to service the developing world's requirements. When Europe and the Americas are included the requirement is closer to 40 million barrels per day. It is doubtful that new supplies sufficient to meet this skyrocketing demand will be found from conventional sources.

UNCERTAIN SUPPLIERS

Nor is it just the potential physical shortfall of resources that is a source of concern. An even greater concern lies in the instability of U.S. sources of oil imports.

The top six sources of U.S. oil imports, Canada, Mexico, Saudi Arabia, Venezuela, Nigeria, and Iraq account for 65.1 percent of all foreign crude reaching our shores and 38.9 percent of total domestic consumption. Of these, four, Saudi Arabia, Venezuela, Nigeria, and Iraq provide 38.2 percent of oil imports and 22.6 percent of total consumption. For a variety of reasons, none of the four I just mentioned can be considered a reliable source of supply.Venezuela's President Hugo Chavez is a vocal opponent of the United States who has twice threatened to cut off oil shipments to the United States.

Nigeria's production has been repeatedly disrupted by civil unrest, and some 135,000 barrels of oil per day are lost to theft.

Last month, a terrorist attack on the massive Saudi oil processing facility at Abqaiq was barely thwarted, but not before two of the terrorist's explosive-laden cars were detonated. Moreover, this was not the only instance of an attempt to disrupt the flow of Saudi oil. In the summer of 2002, Saudi Interior Ministry forces blocked an al-Qaeda plot to attack and cripple the loading dock at Ras Tanura which handles 10 percent of the world's oil supplies.

Attacks on oil facilities in Iraq are a frequent occurrence.

Nor are the attacks on U.S. oil supplies a coincidence. In December of 2004, al-Qaeda issued a fatwa that said in part:

> *We call on the mujahideen in the Arabian Peninsula to unify their ranks and target the oil supplies that do not serve the Islamic nation but the enemies of this nation.*

The fatwa went onto declare:

> *Be active and prevent them from getting hold of our oil and concentrate on it particularly in Iraq and the Gulf.*

Clearly, given the instability that characterizes four of our top six sources of oil, the question is not whether we will experience a supply disruption, but rather when. The disruption could occur as a consequence of a terrorist act, or could result from a politically motivated embargo. In the end, it doesn't really matter why a disruption occurs, because the consequences would be identical, and severe.

THE CONSEQUENCES OF DISRUPTION

The supply disruptions of the 1970s cost the U.S. economy between $2.3 trillion and $2.5 trillion. Today, such an event could carry a price tag as high as $8 trillion—a figure equal to 62.5 percent of our annual GDP or nearly $27,000 for every man, woman, and child living in America.

But there is more cause for concern over such an event than just the economic toll. A supply disruption of significant magnitude, such as would occur should Saudi supplies be interdicted, would also dramatically undermine the nation's ability to defend itself.

Oil has long been a vital military commodity, but today has taken on even more critical importance. Several examples illustrate this point:

- A contemporary U.S. Army Heavy Division uses more than twice as much oil on a daily basis as an entire World War II field army.
- The roughly 582,000 troops dispatched to the Persian Gulf used more than twice as much oil on a daily basis as the entire 2-million man Allied Expeditionary Force that liberated Europe in World War II.
- In Operation Iraqi Freedom, the oil requirement for our Armed Forces was 20 percent higher than in the first gulf war, Operation Desert Storm, and now amount to one barrel of refined petroleum products per day for each deployed service member.

Moreover, the military's oil requirements will be even higher in the future.

Therefore, a shortage of global oil supplies not only holds the potential to devastate our economy, but could hamstring our armed forces as well.

THE HIDDEN COST OF IMPORTED OIL

While it is broadly acknowledged that our undue dependence on imported oil would pose a threat to the nation's economic and military security in the event of a supply disruption, less well understood is the enormous economic toll that dependence takes on a daily basis.

The principal reason why we are not fully aware of the true economic cost of our import dependence is that it largely takes the form of what economists call "externalities," that is, costs or benefits caused by production or consumption of a specific item, but not reflected in its pricing. It is important to understand that even though external costs or benefits may not be reflected in the price of an item, they nonetheless are real.

In October 2003, my organization, The National Defense Council Foundation, issued "America's Achilles Heel: The Hidden Costs of Imported Oil," a comprehensive analysis of the external costs of imported oil. The study entailed the review of literally hundreds of thousands of pages of documents, including the entire order of battle of America's Armed Forces and more than a year of effort. Its conclusions into divided the externalities into three basic categories: Direct and Indirect economic costs, Oil Supply Disruption Impacts, and Military Expenditures.

Taken together, these costs totaled $304.9 billion annually, the equivalent of adding $3.68 to the price of a gallon of gasoline imported from the Persian Gulf.

As high as these costs were, however, they were based on a crude oil refiner acquisition cost of $26.92. Today, crude oil prices are hovering around $60 per barrel and could easily increase significantly. Indeed, whereas in 2003 we spent around $99 billion to purchase foreign crude oil and refined petroleum products, in 2005 we spent more than $251 billion, and this year we will spend at least $320 billion.

But skyrocketing crude oil prices were not the only factor affecting oil-related externalities. Defense expenditures also changed.

In 2003, our Armed Forces allocated $49.1 billion annually to maintaining the capability to assure the flow of oil from the Persian Gulf.

I should note that expenditures for this purpose are not new. Indeed, last year marked the 60th anniversary of the historic meeting between Saudi monarch King Abdul Aziz and U.S. President Franklin Roosevelt where he first committed our nation to assuring the flow of Persian Gulf oil—a promise that has been reaffirmed by every succeeding President, without regard to party.

In 1983 the implicit promise to protect Persian Gulf oil supplies became an explicit element of U.S. military doctrine with the creation of the United States Central Command, CENTCOM. CENTCOM's official history makes this clear stating in part:

> *Today's command evolved as a practical solution to the problem of projecting U.S. military power to the gulf region from halfway around the world.*

I am stressing the longstanding nature of our commitment to the gulf to underscore the fact that our estimates of military expenditures there are not intended as a criticism. Quite the opposite, in fact. Without oil our economy could not function, and therefore protecting our sources of oil is a legitimate defense mission, and the current military operation in Iraq is part of that mission.

To date, supplemental appropriations for the Iraq War come to more than $251 billion, or an average of $83.7 billion per year. As a result, when other costs are included, the total military expenditures related to oil now total $132.7 billion annually.

So, where does that leave us?

In 2003, as noted, we estimated that the "hidden cost" of imported oil totaled $304.9 billion. When we revisited the external costs, taking into account the higher prices for crude oil and increased defense expenditures we found that the "hidden cost" had skyrocketed to $779.5 billion in 2005. That would be equivalent to adding $4.10 to the price of a gallon of gasoline if amortized over the total volume of imports. For Persian Gulf imports, because of the enormous military costs associated with the region, the "hidden cost" was equal to adding $7.41 cents to the price of a gallon of gasoline. When the nominal cost is combined with this figure it yields a "true" cost of $9.53 per gallon, but that is just the start.

Because the price of crude oil is expected to remain the $60 range this year, expenditures for imports are expected to be at least $320 billion this year. That amounts to an increase of $70 bil-

lion in spending for foreign oil in just one year. That increase would raise the total import premium or "hidden cost" to $825.1 billion, or almost twice the President's $419.3 billion defense budget request for fiscal year 2006. If all costs are amortized over the total volume of imports, that would be equivalent to adding $5.04 to the price of a gallon of gasoline. For Persian Gulf imports, the premium would be $8.35. This would bring the "real" price of a gallon of gasoline refined from Persian Gulf oil to $10.86. At these prices the "real" cost of filling up a family sedan is $217.20, and filling up a large SUV $325.80.

But, can anything be done about this enormous drain on our economy? The answer to that question is, "yes."

SOLVING THE PROBLEM

The simple truth is that we do not suffer from a lack of energy resources. Rather, what we suffer from is a lack of the political will and public consensus to use them.

As Pogo said, "We have met the enemy and they is us."

What then can we do?

The first step is to recognize that we face a two-fold problem. The first part entails assuring adequate fuel supplies for the 220 million privately owned vehicles on the road today. These vehicles have an average lifespan of 16.8 years and the average age of our vehicle fleet is 8.5 years. Therefore, we will require conventional fuels or their analogs for at least a decade, even if every new vehicle produced from this day forth runs on some alternative.

The second part of the problem is how to affect a transition to alternatives to conventional petroleum. This transition will take much longer than a decade—perhaps a generation or more—but the longer we delay beginning to make the change, the longer it will take to accomplish.

In the near term, say the next 5 to 10 years, we essentially have two options. First, to make the greatest possible use of our readily accessible conventional domestic resources, particularly the oil and natural gas that lay off our shores. We should also consider using some of our 1,430 trillion cubic feet of domestic gas reserves as a feedstock for motor fuels produced through the Fischer-Tropsch process. Indeed, we currently have 104 trillion cubic feet of so-called "stranded" natural gas in Alaska and a pipeline with some 1.1 million barrels per day of excess capacity. Stranded gas could be converted into clean burning motor fuel and transported in the existing pipeline to the lower 48 states.

We can also expand our use of renewable fuels such as alcohol and biodiesel. A concerted program to make full use of them could significantly add to our motor fuel stocks within the stated time frame.

We should also encourage the acquisition of advanced vehicle technologies such as flex-fuel vehicles, hybrids and plug-in hybrids and vehicles that use propane or natural gas. At the same time, we should encourage the installation of biodiesel and E–85 pumps in our nation's filling stations so that the infrastructure for alternative fuels can keep pace with the growth of the alternative fuel vehicle fleet.

Another point is to make sure that we do not forget to address nontransportation petroleum consumption. The fact that two-thirds of our petroleum is consumed in the transportation sector means that one-third is not. The opportunities to reduce oil consumption from nontransportation are greater than you might expect.

Take residential energy use for example. Roughly 12 percent of distillate use goes to home heating, most of it imported from the Middle East. Yet, there are alternatives readily available that could totally eliminate this use, and at the same time save consumers money. For instance, a developer in Moline, IL, is currently building homes that are between 85 percent and 90 percent energy efficient, and meet their heating and cooling requirements with geothermal energy. More important, these homes are being sold for 20 percent less than conventional housing sold in the same area. So consumers are not only saving energy, they are saving enormous amounts of money.

There is another commercial process that converts waste wood into a zero-sulfur industrial boiler fuel. Our Clean Forests program that removes dead wood and debris from national forests to prevent fires is generating an enormous amount of such waste wood, and that is just the tip of the iceberg. Oak Ridge National Laboratory estimates that a total of 1.366 billion tons of biomass is available for energy production each year. Utilizing this process, it could be turned into 5.6 million barrels of oil per day, or close to 27 percent of our total domestic requirements.

These, of course, are just two examples. Many more exist. The important consideration is that we have a wealth of options that could help in the near to intermediate term if we would only make use of them. To do this, however, we must have leadership.

In this regard, I should note that Chairman Lugar and his colleagues, Senators Chaffee, Coleman, Nelson, and Obama, deserve particular praise for their sponsorship of S. 2025, the Vehicle and Fuel Choices for American Security Act, which is based on the Energy Security Blueprint of the Set America Free Coalition, of which I was a founding member. It is focused on reducing our dependence on foreign oil, not by compromising the American way of life, but by encouraging fuel choice, utilization of the vast array of America's domestic energy resources and accelerated deployment of advanced vehicle technologies. It is clear that this sort of bipartisan effort is exactly the kind of action that is required if we are to make any progress on this critical issue.

In the longer term, there are other domestic energy resources that can be brought into play. We have between 500 billion and 1.1 trillion barrels of oil contained in our huge oil shale resources. We have 496.1 billion tons of demonstrated coal reserves—27 percent of the world total. We also have 320,222 trillion cubic feet of natural gas in the form of methane hydrates. This is equivalent to 51.1 trillion barrels of oil. Indeed one on-shore deposit in Alaska alone contains 519 trillion cubic feet of natural gas. That is equal to 82.9 billion barrels of oil.

We also have 4.85 billion pounds of uranium reserves. Harnessing this vital resource to provide electricity for our cities, towns, and farms is only common sense. Moreover, it could serve

to reduce the need to use natural gas for electricity generation, preserving it for higher uses.

There is one final point I want to make sure is not forgotten. Some portion of every dollar we spend on imported oil finds its way into the hands of individuals who wish to do us harm. The simple truth is that international terrorism stands on two financial pillars: Oil and the drug trade. To the extent that we reduce the revenues generated by either of these activities, we hinder the ability of terrorists to operate.

To conclude, while we our nation is in dire peril due to its excessive dependence on imported oil, the situation is far from hopeless. We have the resources necessary to provide our nation's energy needs if we can only find the political will to do so.

PREPARED STATEMENT

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BEFORE THE

U.S. SENATE COMMITTEE ON FOREIGN RELATIONS

MARCH 30, 2006

Thank you, Chairman Lugar, Ranking Member Biden, and distinguished members of the committee, for the opportunity to discuss with you today the hidden cost of oil.

Tight oil markets with minimal surplus capacity have made world oil prices particularly jumpy over recent months. In the last 6 months, a series of political and natural events have cascaded around the globe and left their impact on increasingly nervous oil-consuming nations. These developments have been extremely varied and include the following:

- A thwarted suicide attack in February at the Abqaiq oil processing facility in eastern Saudi Arabia;
- A string of turmoil in the Niger Delta highlighted by a recent speedboat attack in January by gunmen on the riverside offices of Italian oil company Agip;
- Antigovernment attempts to disrupt congressional elections in Venezuela culminating in an explosion at an oil pipeline connected to that country's largest oil refinery; and
- Devastating hurricanes Katrina and Rita in the United States in August and September.

Their sporadic nature conveys an element of unpredictability and surprise.

I have recently coordinated several studies for the Energy Modeling Forum at Stanford University that relate directly to this issue. I would like to share a few observations that I think summarize the perspectives of many (but certainly not all) participants who were involved in the studies. Our forum frequently brings together the leading experts and advisors from government, business, and university and other research organizations to discuss how we can improve analysis of key energy problems that keep policymakers awake at night. In this particular case, the work was done primarily for the U.S. Department of Energy, but we were asked to invite individuals we thought were the leading people on this issue.

Our two studies focused on the risks of another major oil disruption and the economic consequences of oil price shocks. I am also submitting both reports that expand considerably over my brief remarks here today. I will also briefly discuss a third issue: Our dependence on the oil-producing cartel.

Although these episodes have made oil-importing countries nervous and have imposed some very high costs on people and infrastructure, they have yet to duplicate the types of oil shocks that were experienced during the 1970s and early 1990s. As a result, their economic impacts have been more tolerable than in the past. Despite recent oil price volatility, for example, real GDP in the United States has grown strongly, by 3.5 percent annually since the end of 2001.

A number of knowledgeable experts, however, are concerned about the very real possibility of much more damaging shocks in the future. A group assembled by Stanford's EMF thought that the odds of, at least, one very damaging shock over the next 10 years were higher than those of an oil market with some volatility but without such a shock. Although another major oil disruption is not a certainty, its likelihood is significantly high enough to be worrisome.

Your odds of drawing a club, diamond, or heart from a shuffled deck of playing cards are three out of four. In the EMF study, the participants found that the odds of a foreign oil disruption happening over the next 10 years are slightly higher at 80 percent. Disruption events included surprise geopolitical, military, or terrorist turmoil that would remove at least 2 million barrels per day—an amount representing about 2.1 percent of expected global oil production. Foreign disruptions of this magnitude would have more serious effects on oil prices and the economy than we have seen with the Katrina and Rita hurricanes. Oil prices, however, would rise more and for longer than a few months or a heating season.

In the study, experts estimated the amount of oil lost to the market as the number of barrels removed by the initial disruption, minus any offsets from the use of excess capacity from undisrupted regions. The experts were asked to exclude any releases from the U.S. strategic petroleum reserve, as these actions require separate decisions from the government during an emergency.

The approach identified four major supply regions where disruptions are most likely. These regions account for approximately similar shares of total world oil production. Collectively, they account for about 60 percent of total world oil production. The study lumped Algeria, Angola, Libya, Mexico, Nigeria, and Venezuela as the first region, called "West of Suez." Saudi Arabia was the second region, and other Persian Gulf states—Iran, Iraq, Kuwait, Qatar, UAE, and Oman— were the third. Russia and the Caspian states comprised the fourth region.

The riskiest areas were the Persian Gulf countries outside of Saudi Arabia and several countries along the Atlantic Basin, such as Nigeria and Venezuela. The least risky area was Russia and the Caspian states. Although the participants found the possibility of disruptions was lower in Saudi Arabia than in several other vulnerable regions, disruptions there would tend to have larger effects.

In the second study on the economic consequences of a major disruption, we sought to understand how easily the economy could absorb such a shock. Figure 1 shows that oil price shocks preceded 9 of the last 10 recessions in the United States. The solid line indicates the path of inflation-adjusted crude oil prices since 1950. The gray bars denote periods when the U.S. economy was experiencing recessions as defined by the National Bureau of Economic Research (NBER). This finding was first advanced by Professor James Hamilton at University of California at San Diego and has been confirmed by numerous other researchers.

If a large disruption does occur, we can expect very serious economic consequences. Large disruptions, especially if they move inflation-adjusted oil prices higher than experienced recently, will cause unemployment and excess capacity to grow in certain key sectors. Many large-scale models of the U.S. economy estimate that the level of real GDP could decline by 2 percent for a doubling of oil prices. Since the economy is growing more rapidly than 2 percent per year, that impact would not mean a recession.

Other researchers, however, think that these estimates underestimate the impacts, because they do not focus explicitly on sudden and scary oil price shocks. These other researchers think that our historical experience suggests that the level of real GNP would decline by more, at 5 percent for a doubling of the oil price. My personal view is that the higher estimate may be closer to what would actually happen if we had a major disruption. That would mean a recession.

Some people think that oil shocks may not be a problem because the Federal Reserve Board could intervene and lessen the impact. I have a great deal of faith in the Federal Reserve Board. They have done a marvelous job in controlling inflation, which places the U.S. economy in a better position for offsetting oil disruptions than in previous decades. I am not yet convinced that they can compensate the economy for a large devastating disruption. They would have to make some important decisions very quickly at a time when fears were running rampant. They may also find it difficult to stimulate the economy because nominal interest rates are already very low, not only here but also abroad. For this reason, I think that the United States should seriously consider other types of insurance policies that would allow the Federal Reserve Board more leeway and flexibility in controlling our inflation rates.

As a general rule, strategies that reduce our dependence on oil consumption are more effective than policies that reduce our imports. One should view the world oil market as one giant pool rather than as a series of disconnected puddles. When events happen anywhere in the market, they will raise prices not only there but also everywhere that connect to that large pool. Since reducing our imports with our own production does not sever our link to that giant pool, disruptions will cause prices to rise for all production, including that originating in the United States. More domestic supplies do not protect us from these price shocks.

Unfortunately, insurance policies are never free. It will cost us something to implement a strategy that reduces our risk to another major oil disruption. But it will also cost us a lot of money and jobs

if we do not adopt an insurance policy and the nation faces another major disruption.

As a result of the 1970 oil price shocks, we shifted away from oil in many sectors in the early 1980s, but that trend has slowed considerably since then. Moreover, transportation remains strongly tied to oil use. The dependence on oil in transportation not only affects households directly through higher gasoline costs but it also raises the costs of transporting goods around the country.

Our most recent studies did not address a third issue that could influence the costs of using oil. It is sometimes argued that the United States could adopt policies that would try to minimize or break the oil-producing cartel's control over the market. Our forum addressed this issue many years ago. Although the range of views was wide, our working group conservatively estimated that the hidden cost of oil from this source might be $5 per barrel, or 12 cents per gallon. Several years ago, the National Research Council used a very similar estimate in their review of the corporate average fuel economy standards for automobiles. That estimate is not trivial, but it is considerably smaller than various estimates for gasoline's hidden costs due to pollution, congestion and automobile accidents.

In summary, the nation is vulnerable to another major disruption not because the economy imports oil but primarily because it uses a lot of oil, primarily for gasoline and jet fuel. Even if domestic production could replace all oil imports, which I am not advocating, the economy would remain vulnerable to the types of disruptions discussed here. However, it is very appropriate that this committee focus its energy on this issue. Oil-importing governments have committed significant political and military resources to the Middle East over a number of decades in order to provide regional stability that is critical to world oil supplies. Excessive exposure to oil vulnerability risks in this country increases these costs or reduces the capacity to pursue foreign policy objectives that are critical for mitigating nuclear proliferation, terrorism, and other risks that reduce global security. I cannot provide you with an estimate for this political cost of using oil, but it is extremely important.

PREPARED STATEMENT

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BEFORE THE

U.S. SENATE COMMITTEE ON FOREIGN RELATIONS

MARCH 30, 2006

Mr. Chairman, Senator Biden, and members of the Committee on Foreign Relations, thank you for your invitation to present testimony in on "The Hidden (Climate Change) Costs of Oil". It is indeed an honor to be here, today.

The task that I accepted when I agreed to testify involves providing some insight into the economic cost of carbon emissions so that you can "back out the share of oil to get the right order of magnitude." I am afraid, however, that this deceptively complicated question has the same answer as nearly every other question in economics: "It depends." My testimony will therefore be directed at providing insight into the underlying factors upon which these costs depend. I will, however, also offer some thoughts about what the underlying uncertainty means for climate policy and the hidden cost of oil.

I will begin with a brief review of the range of more than 100 published estimates of what is termed the "social cost of carbon"; this is the calculation by which we can attribute a share of cost to oil based on its carbon content (per unit energy). I will highlight why the range of these estimates is so large. I will suggest which of the factors that make the range so large can be influenced by political decisionmakers, but I will also focus attention on scientific factors that are beyond their control. Thinking about how we should cope with these scientific factors will lead me to identify two fundamental sources of hidden cost that may not be immediately obvious.

I will, in particular, suggest an alternative way to calculate the hidden climate costs of oil based explicitly on hedging against the potentially severe economic costs of abrupt changes in policy. These policy adjustments may be required over the near to moderate term as we come to know more about the impacts and/or likelihoods of climate change (particularly abrupt climate change). It is important to recognize that many of these impacts have not yet been included in the direct calculation of social cost. Adopting a risk-management (hedging) approach to minimize the cost of future policy adjustments is therefore an appropriate, economically rational way to

think about the social cost of carbon. Moreover, it makes uncertainty a reason to act immediately rather than a reason to procrastinate.

I will, as well, argue that ignoring social costs calculated by either a tradition direct method or one derived from a risk-management approach systematically undervalues projects and programs that would reduce our consumption of petroleum (like investment in ethanol as an alternative source of energy) while it produces an symmetric overvaluation of projects and programs that would do just the opposite (like drilling in the Arctic National Wildlife Refuge).

To begin, I recall "burning ember" diagram from the Third Assessment Report (the TAR) of the Intergovernmental Panel on Climate Change (2001) in Figure 1. It duplicates Figure TS–12 from the Technical Summary of the Third Assessment Report where five Lines of Evidence" were identified. These are the five sources of concern, or indicators of vulnerability, that have captured our attention. Two are essentially economic indicators of aggregate impacts at the global and regional levels. They are dominated by estimates of the costs of the climate impacts in market-based sectors like real estate (in response to rising seas), agricultural, energy, and the like. As such, they do include evaluations of how various nations and even communities within nations might adapt to climate-related stress. It is important to recognize, of course, that these impacts are felt unevenly across the globe. Panel A of Figure 2 offers a representative portrait of a possible geographic distribution of vulnerability to climate impacts in 2050 calibrated in terms of aggregate impacts. Developing countries show up as most vulnerable, but developed countries are surely not immune to climate risk even when their superior capacities to adapt are recognized.

A third row in Figure 1 focuses attention squarely on ecosystems, although the IPCC did not provide the detailed assessment of ecosystem services that was so thoroughly documented in the recently completed Millennium Ecosystem Assessment. The last two rows reflect vulnerability to two potentially more significant areas concern: "Risks from Future Large-Scale Discontinuities" and "Risks from Extreme Weather Events". Figure 2 illustrates the uneven impact point by displaying a plausible global distribution of vulnerability in 2050 calibrated to the risks of extreme weather events. Developing countries are still most vulnerable, but developed countries also face significant vulnerabilities from a more urgent "source of concern."

Economists have been trying for some time to assign currency values to the impacts of climate change identified in Figure 1 by tracking their potential trajectories along long-term scenarios of how the future might unfold. Not surprisingly, economists do not agree on what that future might hold. They do, however, agree on what measure to use: "The social cost of carbon." What is that? It is the damage caused over time by releasing an addition unit of ton of carbon in the atmosphere discounted back to the year of its emission. That is to say, the social cost of carbon represents the "marginal cost" of emissions; alternatively, it represents the "marginal benefit" of unit of carbon emissions reduction. Most importantly for present purposes, the social cost of carbon, when modi-

fied by the carbon content of petroleum, is the hidden (climate change) cost of oil.

Figure 3 displays the range of more than 100 estimates currently available in the published literature; it is derived from Tol (2005). Panel A of Figure 3 displays the social cost in dollars per metric ton of carbon; Panel B tracks the estimate to the hidden cost of oil by expressing social cost in dollars per barrel of oil.

How should the data portrayed in Figure 3 be read? Percentile values are recorded up the vertical axis for cost estimates ordered from lowest to highest. So, for example, point A indicates that 12 percent of the published estimates were below $0. Point B highlights the median estimate, suggesting that 50 percent of the estimates were below $13 per ton of carbon ($2 per barrel of oil), and 50 percent of the estimate were above this benchmark. Point C shows that 20 percent of the estimates were above $73 per ton of carbon ($9 per barrel of oil). Finally, the average across all of the published estimates is $85 per ton ($11 per barrel of oil).

How should the content of Figure 3 be read, given all of the disagreement that it reveals? Richard Tol, an economist from Germany, read the data to mean that $45 per ton should be interpreted as the upper bound for a reasonable "best" estimate of the social cost of carbon; this is $6 per barrel of oil. Thomas Downing (2005), a geographer from the Stockholm Environment Institute office in the United Kingdom looked at the same distribution through the lens of enormous experience in developing countries where changes in climate produce enormous displacement effects that cannot be quantified in terms of currencies. He read the data to mean that $45 per ton or $6 per barrel of oil should be interpreted as a lower bound to the true social cost of carbon.

I have been told that presenting such a figure in a political environment would allow people who do not think that climate is a problem to focus on the lower part of range and people who think that climate is a large problem to focus on the upper part of the range. Productive conversations between the two sides, I have also been told, would seldom be a product of such readings.

For this, and a few other reasons, I now preach caution to all. To appropriately read Figure 3, we must work to understand what is going on behind the scenes. Why is the range so large? Which of the "Lines of Evidence" do the estimates include, and which do they miss? What combinations of underlying factors produce low or even negative estimates of social cost, and what other combinations support estimates on the high end of the scale? Answers to these questions can be enormously revealing.

The choice of discount rate and the incorporation of equity weights are extremely important, and both lie within the purview of decisionmakers. High discount rates sustain low estimates because future damages become insignificant. Conversely, low discount rates produce high estimates because future damages are important. Meanwhile, strong equity weighting across the globe support high estimates because poor developing countries are most vulnerable. Conversely, weak or no equity weighting can produce low estimates because poor developing countries do not factor heavily in the overall calculation.

It turns out, however, that several scientific parameters that decisionmakers cannot choose are even more important in explaining the variability depicted in Figure 3. Indeed, climate sensitivity (i.e., the increase in global mean temperature that would result from a doubling of greenhouse gas concentrations from preindustrial levels) is the largest source of variation. It is possible to derive high estimates for the social cost of carbon even if you assume low discount rates and almost no equity weighting. All that is required is the assumption that the climate sensitivity lies at the high range of the latest range of estimates. Andronova and Schlesinger (2001), for example, find that the historical record could easily be explained with climate sensitivities as high as 8 or 9 degrees Centigrade (even though the TAR reported an upper bound of 5.5 degrees).

Moreover, none of the estimates from which Figure 3 was drawn include the economic costs of "Risks from Extreme Climate Events" or "Risks from Future Large-Scale Discontinuities."

To offer one glimpse at the role that these sources of concern might play, I can report the results of some more recent work that focuses on what we know about when the Atlantic thermohaline circulation (the Gulf Stream when it flows close to the United States) might weaken or suddenly collapse. Schlesinger, et al. (2006) put the chance of collapse at 50 percent if the global mean temperature were to climb by another 2 degrees Centigrade. Put another way, Yohe, et al. (2006) show more than a 40 percent chance of collapse by 2105 along a "middle of the road" emissions scenario. Imposing a global policy targeted at a $100 per ton social cost of carbon ($12 per barrel of oil) would reduce that likelihood to 25 percent if it were initiated immediately; but only to 35 percent if it were delayed by 30 years.

At this point, it is essential to re-emphasize the point that none of these critical scientific factors can be decided by committee deliberation and popular elections. Their values are up to nature to decide, and we simply do not know what she has in the cards for us. The bottom-line is that the planet faces significant risks whose economic impacts have not yet been quantified. We have some idea of their likelihood, though, and so it is impossible to claim with certainty that they will not materialize as the future unfolds.

What should we do? We should recognize that the climate policy will be adjusted over time as we learn more, especially if all (or even one) of the really bad news scenarios begin to materialize. We should also recognize that these adjustments could significantly and immediately change the economic environment in which we will be living. Moreover, we should recognize that these adjustments might be required sooner rather than later.

All of this risk in the policy realm suggests an alternative method for estimating the social cost of carbon. Yohe, et al. (2004) conducted a simple "act-then-learn" experiment which showed that the expected discounted cost of global policy adjustment in 2035 could be minimized if a modest hedging policy were begun now. Their work suggests a risk-based social cost of carbon in 2005 equal to about $10 per ton ($1.50 per barrel of oil). And their approach makes uncertainty is the reason to act in the near term rather than a reason to delay.

To be clear, tacking on $1.50 to the price of a barrel of oil will not do the trick. This risk based social cost would increase over time at the rate of interest. So it would be $3 per barrel in 2020 and $5 per barrel just after 2030. The critical component of the policy, and this estimate of social cost, is not the starting point. Consistent with the observation by Watkiss, et al. (2005) that the traditionally computed social cost of carbon increases over time, it is the persistent and predictable ratcheting-up of the effective price of carbon that would give the hedging strategy any traction at all.

This observation brings me to my last point—identifying a second potentially expensive consequence of ignoring the hidden climate cost of oil. Failing to include estimates of the social cost of the carbon content of oil simply makes projects that use more oil or provide more oil more likely to go forward. Why? Because the calculations upon which the investment decisions would be made would inappropriately underestimate true costs. They would, in other words, show exaggerated benefit-cost ratios because the denominators would be too low. Conversely, failing to include the social cost of the carbon content of oil makes projects that conserve oil or provide alternative sources of energy less likely to go forward. They would simply show deflated benefit-cost ratios because the numerators would be too low.

So, what if I had to pick a number? What would I say if asked to estimate place the hidden social cost of oil in perspective? I think that my $1.50 per barrel risk-based estimate is too low, since our analysis assumed immediate global participation in any policy response 2005 and it captured only a very limited set of possible sources of uncertainty. Given all of the impacts that are not yet part of the more traditional approaches, though, I do not think that the $6 per barrel estimate that separated Tol from Downing is too high. If pressed, I would probably say $5 per barrel for 2006, but I could be just as comfortable with $10. Indeed, I would insist only that the social cost attributed to oil for its climate impacts increase over time at the real rate of interest.

Again, thank you for the opportunity to be here today, and thank you for your attention.

"HIGH COST OF CRUDE: THE NEW CURRENCY OF FOREIGN POLICY"

Wednesday, November 16, 2006

OPENING STATEMENT

HON. RICHARD G. LUGAR

U.S. SENATOR FROM INDIANA,
CHAIRMAN, SENATE COMMITTEE ON FOREIGN RELATIONS

The committee meets today to examine the effects of U.S. oil consumption on American foreign policy and on our wider economic and security interests. High oil prices have hurt American consumers at the gas pump, and record revenues flowing into oil producing nations are changing the world's geopolitical landscape. Increasingly, oil is the currency through which countries leverage their interests against oil dependent nations such as ours.

Oil is not just another commodity. It occupies a position of singular importance in the American economy and way of life. In 2003, each American consumed about 25 barrels of oil. That is more than double the per capita consumption in the United Kingdom, Germany, and France and more than 15 times that of China. With less than 5 percent of the world's population, the United States consumes 25 percent of its oil.

Higher oil prices have helped drive the consumer price index up 4.7 percent during the past year. Motorists felt this pinch at the pump long before the destruction of Hurricanes Katrina and Rita. This year, the United States has spent about $19 billion per month on oil imports. The cost of imported oil now accounts for approximately one-third of our trade deficit.

In the short run, our dependence on oil has created a drag on economic performance at home and troubling national security burdens overseas. In the long run, this dependence is pushing the United States toward an economic disaster that could mean diminished living standards, increased risks of war, and accelerated environmental degradation.

Up to this point, the main issues surrounding oil have been how much we have to pay for it and whether we will experience supply disruptions. But in decades to come, the issue may be whether the world's supply of oil is abundant and accessible enough to support continued economic growth, both in the industrialized West and in large rapidly growing economies like China and India. When we reach the point where the world's oil-hungry economies are com-

peting for insufficient supplies of energy, oil will become an even stronger magnet for conflict than it already is.

Since 1991, we have fought two major wars in the oil-rich Middle East, and oil infrastructure and shipping lanes are targets for terrorism. In addition to the enormous dollar cost we pay for the military strength to maintain our access to foreign oil, our petroleum dependence exacts a high price in terms of foreign policy and international security.

Massive infusions of oil revenue distort regional politics and can embolden leaders hostile to U.S. interests. Iran, where oil income has soared 30 percent this year, threatened last month to use oil as a weapon to protect its nuclear ambitions. At a time when the international community is attempting to persuade Iran to live up to its nonproliferation obligations, our economic leverage on Iran has declined due to its burgeoning oil revenues. Similarly, the Chavez government in Venezuela resists hemispheric calls for moderation, in part because it has been emboldened by growing oil revenues. Russia uses its gushing oil and natural gas income and reserves as leverage over new democracies in East Europe. Globally, critical international security goals, including countering nuclear weapons proliferation, supporting new democracies, and promoting sustainable development are at risk because of dependence on oil.

Diversification of our supplies of conventional and nonconventional oil, such as Canada's tar sands, is necessary and under way. Yet because the oil market is globally integrated, the impact of this diversification is limited. Our current rate of oil consumption, coupled with rapidly increasing oil demand in China, India, and elsewhere, will leave us vulnerable to events in the tumultuous Middle East and to unreliable suppliers such as Venezuela. Any solution will require much more than a diversification and expansion of our oil supply.

Despite the widening discussion of our energy vulnerability, the U.S. political system has been capable of only tentative remedial steps that have not disturbed the prevailing oil culture. The economic sacrifices imposed on Americans recently by rising oil prices have expanded our nation's concern about oil dependence. But in the past, as oil price shocks have receded, motivations for action have also waned. Currently, policies for mediating the negative effects of oil dependence continue to be hamstrung in debate between supply-side approaches and those preferring to decrease demand. We must consider whether the political will now exists to commit to a comprehensive strategy.

Our weak response to our own energy vulnerability is all the more frustrating given that alternatives to oil do exist. Oil's importance is the result of industrial and consumption choices of the past. We now must choose a different path. Without eliminating oil imports or abandoning our cars, we can offset a significant portion of demand for oil by giving American consumers a real choice of automotive fuel. We must end oil's near monopoly on the transportation sector, which accounts for 60 percent of American oil consumption.

I believe that biofuels, combined with hybrid and other technologies, can move us away from our extreme dependence on oil. Corn-based ethanol is already providing many Midwesterners with

a lower cost fuel option. Cellulosic ethanol, which is made of more abundant and less expensive biomass, is poised for a commercial takeoff. We made progress in the 2005 energy bill, which includes incentives to produce 7.5 billion gallons of renewable biofuel annually. I introduced legislation last week that would require manufacturers to install flexible-fuel technology in all new cars. This is an easy and cheap modification, which allows vehicles to run on a mixture of 85 percent ethanol and 15 percent gasoline.

We will get even greater payoffs for our investment in oil alternatives if American technological advances can be marketed to the rest of the world. Nations containing about 85 percent of the world's population depend on oil imports. These nations could reap many of the same security and economic benefits by breaking their oil import chains. Developing countries could improve their balance of payments and promote rural development by growing profitable biomass, while offering new markets for fuel technologies.

We need to think creatively about cooperating with other countries to address today's global energy challenges. For example, earlier this month I introduced S. 1950, "The United States-India Energy Security Cooperation Act of 2005." This bill would promote greater cooperation with India on clean coal technology, ethanol, and other energy sources.

I am particularly pleased to welcome two old friends, today, who will assist us in our inquiry today. Dr. James Schlesinger, former Secretary of Defense, Secretary of Energy, and Director of Central Intelligence, has seen America through oil shocks and has remained committed to improving America's energy situation. He is a keen analyst of the geopolitical consequences of oil dependence, as well as an authority on America's energy future.

Also joining us is Mr. James Woolsey, former Director of Central Intelligence. In 1999, Jim and I—and I would stress my dependance on his tutelage in this—coauthored "The New Petroleum," an article in Foreign Affairs that laid out the case for a greater role for cellulosic ethanol. He has continued to serve as a leading advocate for forward-looking reforms of our energy policy. We thank our distinguished witnesses for coming and look forward to their insights.

PREPARED STATEMENT

HON. JAMES SCHLESINGER

SENIOR ADVISOR, LEHMAN BROTHERS, WASHINGTON, DC

BEFORE THE

U.S. SENATE COMMITTEE ON FOREIGN RELATIONS

NOVEMBER 16, 2005

Mr. Chairman, members of the committee, I thank the committee for this opportunity to discuss the quest for energy security, the implications of our heavy dependence on imported oil, the rise in oil prices, and their manifold political and economic repercussions for our nation. In so many ways, the use of oil as our primary energy source turns out to be a two-edged sword. Given that dependence, the ramifications are too numerous to discuss in detail. Given the necessary limitations on time, I must be selective. Therefore, I shall touch only upon several salient points.

1. Mr. Chairman, the problem of energy security is of relatively recent origin. When mankind depended upon windmills, oxen, horses, etc., energy security was not a strategic problem. Instead, as a strategic problem it is a development of modem times—and reflects most crucially the turn to fossil fuels as increasingly the source of energy. The Industrial Revolution in the 19th century, strongly reinforced by the rapid growth of oil-dependent transportation in the 20th, unavoidably posed the question of security of supply. Imperial Germany took over Lorraine with its coal fields after the Franco-Prussian War—to insure its energy security. When Britain, pushed by Churchill, converted its Navy to oil early in the 20th century, it sought a secure supply of oil under its own control in the Persian Gulf—which incidentally increased its concern for the security of the Suez Canal. For the United States, where the production of oil had started and for long was primarily located, the question of security of supply did not arise until the 1960s and 1970s. Since then, we have regularly talked about—and sought by various measures—to achieve greater energy security. Such measures, limited as they were, have generally proved unsatisfactory. The nation's dependence on imported hydrocarbons has continued to surge.

Mr. Chairman, until such time as new technologies, barely on the horizon, can wean us from our dependence on oil and gas, we shall continue to be plagued by energy insecurity. We shall not end dependence on imported oil nor, what is the hope of some, end dependence on the volatile Middle East—with all the political and economic consequences that flow from that reality. That is not to

say that various measures and inventions will not, from time to time, shave our growing dependence, but we will not end it. Instead of energy security, we shall have to acknowledge and to live with various degrees of insecurity.

To be sure, we have certain short-term problems to which I shall presently turn. More importantly, we face a fundamental, longer term problem. In the decades ahead, we do not know precisely when, we shall reach a point, a plateau or peak, beyond which we shall be unable further to increase production of conventional oil worldwide. We need to understand that problem now and to begin to prepare for that transition.

The underlying problem is that for more than three decades, our production has outrun new discoveries. Most of our giant fields were found 40 years ago and more. Even today, the bulk of our production comes from these old—and aging—giant fields. More recent discoveries tend to be small with high decline rates—and are soon exhausted. Since the issue is crucial—and is not widely understood—I have prepared a chart which lays bare the problem.

Mr. Chairman, the upshot is, quite simply, that, as the years roll by, the entire world will face a prospectively growing problem of energy supply. Moreover, we shall inevitably see a growing dependency on the volatile Middle East. We shall have to learn to live with degrees of insecurity—rather than the elusive security we have long sought. To be sure, some insecurity will be mitigated by the Strategic Petroleum Reserve, and other emergency measures. That will provide some protection against (short-term) supply disruptions, but it will not provide protection against the fundamental long-term problem.

2. In addition to the long-term problem of the prospective limit on conventional oil production, we have a number of short-term or cyclical problems that have contributed to the current stringency and current high prices. Spare production capacity has essentially disappeared. This reflects the volatility of oil prices, which has led to a low rate of investment in new capacity, as well as an unexpected surge of demand, particularly from China and the United States. For many years, we have had excess capacity in refining. That, too, has largely disappeared, and we lack capacity to refine the heavy, sour crudes that remain available. Here in the United States, the problem has been amplified by the battering of gulf infrastructure by Hurricanes Katrina and Rita. We also have an added, self-inflicted problem of some 17 boutique blends of gasoline, mandated by state authorities.

The insurgency in Iraq has prevented the increase in production, even to the prewar level, that many expected. Long-term sanctions against Iraq, Iran, and Libya, both United States and international, have reduced their contribution to world supply. This has taken place against inelastic domestic production of natural gas. There are, in addition, problems of electric power generation and transmission. The point about all of these is these are not inherent problems. In principal, they would all yield to additional investment. Yet, we must bear in mind that investment activity depends upon price signals, and that there is a long period of gestation before additional investment activity brings supply to market. Some

of these problems may, however, be ameliorated by changes in law or in regulation.

By about 2010, we should see a significant increase in oil production as a result of investment activity now under way. There is a danger that any easing of the price of crude oil will, once again, dispel the recognition that there is a finite limit to conventional oil. In no way do the prospective investment decisions solve the long-term, fundamental problem of oil supply.

3. Let me turn now to the political and economic ramifications. Again, let me underscore that energy actions tend to be a two-edged sword. To some extent, the recent higher prices for oil reflect some of our own prior policies and actions. For example, the sanctions imposed upon various rogue nations, by reducing world supply, have resulted in higher prices. Operation Iraqi Freedom, followed by the insurgency, has caused unrest in the Middle East. The consequence has been somewhat lower production and a significant risk premium that, again, has raised the price of oil.

The effect of higher oil prices has been significantly higher incomes for producers. A much higher level of income has meant that a range of nations, including Russia, Iran, Venezuela, as well as gulf Arab nations have had their economic problems substantially eased. As a result, they have become less amenable to American policy initiatives. Perhaps more importantly, the flow of funds into the Middle East inevitably has added to the moneys that can be transferred to terrorists. As long as the motivation is there and controls remain inadequate, that means that the terrorists will continue to be adequately or amply funded. To the extent that we begin to run into supply limitations and to the extent that we all grow more dependent on the Middle East, this problem of spillover funding benefits for terrorists is not going to go away.

4. There are, of course, additional problems of an economic nature. We all understand that higher oil prices can depress spending on other goods and services—and thereby cause slower growth rates and possibly a worldwide recession. The reverse side of rising receipts for producers is, of course, rising out-payments by consumer nations. This can readily augment structural imbalances. This year, the American balance-of-payments deficit looks to be almost three-quarters of a trillion dollars. That is not small change. Of the well over $700 billion of that deficit, some $300 billion comes from oil and gas. It is recognized that the U.S. balance-of-payments deficit represents the locomotive that drives much of the world's economies. In performing this service—for which we get little thanks—the United States is steadily adding to its financial obligations to others. How long this process can continue is uncertain, but high oil prices add to the dilemma.

Finally, Mr. Chairman, I must point to another problem. The United States is today the preponderant military power in the world. Still, our military establishment is heavily dependent upon oil. At a minimum, the rising oil price poses a budgetary problem for the Department of Defense at a time that our national budget is increasingly strained. Moreover, in the longer run, as we face the prospect of a plateau in which we are no longer able, worldwide, to increase the production of oil against presumably still-rising demand, the question is whether the Department of Defense will still

be able to obtain the supply of oil products necessary for maintaining our military preponderance. In that prospective world, the Department of Defense will face all sorts of pressures at home and abroad to curtail its use of petroleum products, thereby endangering its overall military effectiveness.

In closing, Mr. Chairman, I trust that I have fulfilled the request in your letter of invitation to analyze "the complexity of U.S. reliance on imported energy sources, particularly oil, and the difficulties the United States faces in mediating detrimental effects of this dependency." Even in the short run, actions that we take may substantially increase the resources and reduce the economic and political pressures on states that are hostile to us. In the longer run, unless we take serious steps to prepare for the day that we can no longer increase production of conventional oil, we are faced with the possibility of a major economic shock—and the political unrest that would ensue. The United States has just over 4 percent of the world's population and uses roughly 25 percent of the world's oil production. In a sense, this statistic in itself is misleading, because the United States produces roughly 20 to 25 percent of the gross world product. Nonetheless, that statistic does underscore our potential vulnerability in an era that we may no longer be able to produce additional conventional crude oil worldwide.

Thank you very much, Mr. Chairman. I shall be happy to answer any questions that you or the members of the committee may have.

PREPARED STATEMENT

HON. R. JAMES WOOLSEY

VICE PRESIDENT, BOOZ ALLEN HAMILTON, MCCLEAN, VA

BEFORE THE

U.S. SENATE COMMITTEE ON FOREIGN RELATIONS

NOVEMBER 16, 2005

Mr. Chairman and members of the committee, it's a real pleasure to appear before this committee today on this issue. I am appearing solely on my own behalf and represent no organization. By way of identification I served as Director of Central Intelligence, 1993–95, one of the four Presidential appointments I have held in two Republican and two Democratic administrations; these have been interspersed in a career that has been generally in the private practice of law and now in consulting. The substantial majority of the points I will make today are drawn from an August 2005 paper by former Secretary of State, George P. Shultz, and myself, although I have updated some points due to more recent work; the two of us are cochairmen of the Committee on the Present Danger and the full paper may be found at the committee's Web site (www.fightingterror.org).

Just over 4 years ago, on the eve of 9/11, the need to reduce radically our reliance on oil was not clear to many and in any case the path of doing so seemed a long and difficult one. Today both assumptions are being undermined by the risks of the post-9/11 world, by oil prices, and by technological progress in fuel efficiency and alternative fuels.

There are at least seven major reasons why dependence on petroleum and its products for the lion's share of the world's transportation fuel creates special dangers in our time. These dangers are all driven by rigidities and potential vulnerabilities that have become serious problems because of the geopolitical realities of the early 21st century. Those who reason about these issues solely on the basis of abstract economic models that are designed to ignore such geopolitical realities will find much to disagree with in what follows. Although such models have utility in assessing the importance of more or less purely economic factors in the long run, as Lord Keynes famously remarked: "In the long run, we are all dead."

These dangers in turn give rise to two proposed directions for government policy in order to reduce our vulnerability rapidly. In both cases it is important that existing technology should be used, i.e., technology that is already in the market or can be so in the

very near future and that is compatible with the existing transportation infrastructure. To this end government policies in the United States and other oil-importing countries should: (1) Encourage a shift to substantially more fuel-efficient vehicles within the existing transportation infrastructure, including promoting both battery development and a market for existing battery types for plug-in hybrid vehicles; and (2) encourage biofuels and other alternative and renewable fuels that can be produced from inexpensive and widely available feedstocks—wherever possible from waste products.

PETROLEUM DEPENDENCE: THE DANGERS

1. The current transportation infrastructure is committed to oil and oil-compatible products

This fact substantially increases the difficulty of responding to oil price increases or disruptions in supply by substituting other fuels.

There is a range of fuels that can be used to produce electricity and heat and that can be used for other industrial uses, but petroleum and its products dominate the fuel market for vehicular transportation. With the important exception, described below, of a plug-in version of the hybrid gasoline/electric vehicle, which will allow recharging hybrids from the electricity grid, substituting other fuels for petroleum in the vehicle fleet as a whole has generally required major, time-consuming, and expensive infrastructure changes. One exception has been some use of liquid natural gas (LNG) and other fuels for fleets of buses or delivery vehicles, although not substantially for privately owned ones, and the use of corn-derived ethanol mixed with gasoline in proportions up to 10 percent ethanol ("gasohol") in some States. Neither has appreciably affected petroleum's dominance of the transportation fuel market.

Moreover, in the 1970s about 20 percent of our electricity was made from oil—so shifting electricity generation toward, say, renewables or nuclear power could save oil. But since today only about 3 percent of our electricity is oil-generated, a shift in the way we produce electricity would have almost no effect on the transportation or oil market. This could change over the long run, however, with the advent of plug-in hybrid vehicles, discussed below.

There are imaginative proposals for transitioning to other fuels for transportation, such as hydrogen to power automotive fuel cells, but this would require major infrastructure investment and restructuring. If privately owned fuel cell vehicles were to be capable of being readily refueled, this would require reformers (equipment capable of reforming, say, natural gas into hydrogen) to be located at filling stations, and would also require natural gas to be available there as a hydrogen feed-stock. So not only would fuel cell development and technology for storing hydrogen on vehicles need to be further developed, but the automobile industry's development and production of fuel cells also would need to be coordinated with the energy industry's deployment of reformers and the fuel for them.

Moving toward automotive fuel cells thus requires us to face a huge question of pace and coordination of large-scale changes by both the automotive and energy industries. This poses a sort of industrial Alphonse and Gaston dilemma: Who goes through the door

first? (If, instead, it were decided that existing fuels such as gasoline were to be reformed into hydrogen on board vehicles instead of at filling stations, this would require onboard reformers to be developed and added to the fuel cell vehicles themselves—a very substantial undertaking.)

It is because of such complications that the National Commission on Energy Policy concluded in its December 2004, report "Ending The Energy Stalemate" that "hydrogen offers little to no potential to improve oil security and reduce climate change risks in the next 20 years."

To have an impact on our vulnerabilities within the next decade or two, any competitor of oil-derived fuels will need to be compatible with the existing energy infrastructure and require only modest additions or amendments to it.

2. The Greater Middle East will continue to be the low-cost and dominant petroleum producer for the foreseeable future

Home of around two-thirds of the world's proven reserves of conventional oil—45 percent of it in just Saudi Arabia, Iraq, and Iran—the Greater Middle East will inevitably have to meet a growing percentage of world oil demand. This demand is expected to increase by more than 50 percent in the next two decades, from 78 million barrels per day (bbl/d) in 2002 to 118 bbl/d in 2025, according to the Federal Energy Information Administration. Much of this will come from expected demand growth in China and India. One need not argue that world oil production has peaked to see that this puts substantial strain on the global oil system. It will mean higher prices and potential supply disruptions and will put considerable leverage in the hands of governments in the Greater Middle East as well as in those of other oil-exporting states which have not been marked recently by stability and certainty: Russia, Venezuela, and Nigeria, for example. Deep-water drilling and other opportunities for increases in supply of conventional oil may provide important increases in supply but are unlikely to change this basic picture.

Even if other production comes on line, e.g., from unconventional sources such as tar sands in Alberta or shale in the American West, their relatively high cost of production could permit low-cost producers, particularly Saudi Arabia, to increase production, drop prices for a time, and undermine the economic viability of the higher cost competitors, as occurred in the mid-1980s. For the foreseeable future, as long as vehicular transportation is dominated by oil as it is today, the Greater Middle East, and especially Saudi Arabia, will remain in the driver's seat.

3. The petroleum infrastructure is highly vulnerable to terrorist and other attacks

The radical Islamist movement, including but not exclusively al-Qaeda, has on a number of occasions explicitly called for worldwide attacks on the petroleum infrastructure and has carried some out in the Greater Middle East. A more well-planned attack than what has occurred to date—such as that set out in the opening pages of Robert Baer's recent book, "Sleeping With the Devil" (terrorists flying an aircraft into the unique sulfur-cleaning towers in north-

eastern Saudi Arabia), could take some 6 million barrels per day off the market for a year or more, sending petroleum prices sharply upward to well over $100/barrel and severely damaging much of the world's economy. Domestic infrastructure in the West is not immune from such disruption. U.S. refineries, for example, are concentrated in a few places, principally the gulf coast. The recent accident in the Texas City refinery—producing multiple fatalities—points out potential infrastructure vulnerabilities, as of course does this fall's hurricane damage in the gulf. The Trans-Alaska Pipeline has been subject to several amateurish attacks that have taken it briefly out of commission; a seriously planned attack on it could be far more devastating.

In view of these overall infrastructure vulnerabilities policy should not focus exclusively on petroleum imports, although such infrastructure vulnerabilities are likely to be the most severe in the Greater Middle East. It is there that terrorists have the easiest access, and the largest proportion of proven oil reserves and low-cost production are also located there. Nor is anything particularly useful accomplished by changing trade patterns. To a first approximation there is one worldwide oil market and it is not generally useful for the United States, for example, to import less from the Greater Middle East and for others then to import more from there. In effect, all of us oil-importing countries are in this together.

4. The possibility exists, particularly under regimes that could come to power in the Greater Middle East, of embargoes or other disruptions of supply

It is often said that whoever governs the oil-rich nations of the Greater Middle East will need to sell their oil. This is not true, however, if the rulers choose to try to live, for most purposes, in the seventh century. Bin Laden has advocated, for example, major reductions in oil production and oil prices of $200/barrel or more.

In 1979 there was a serious attempted coup in Saudi Arabia. Much of what the outside world saw was the seizure by Islamist fanatics of the Great Mosque in Mecca, but the effort was more widespread. Even if one is optimistic that democracy and the rule of law will spread in the Greater Middle East and that this will lead after a time to more peaceful and stable societies there, it is undeniable that there is substantial risk that for some time the region will be characterized by chaotic change and unpredictable governmental behavior. Reform, particularly if it is hesitant, has in a number of cases been trumped by radical takeovers (Jacobins, Bolsheviks). There is no reason to believe that the Greater Middle East is immune from these sorts of historic risks.

5. Wealth transfers from oil have been used, and continue to be used, to fund terrorism and its ideological support

Estimates of the amount spent by the Saudis in the last 30 years spreading Wahhabi beliefs throughout the world vary from $70 billion to $100 billion. Furthermore, some oil-rich families of the Greater Middle East fund terrorist groups directly. The spread of Wahhabi doctrine—fanatically hostile to Shiite and Suffi Muslims, Jews, Christians, women, modernity, and much else—plays a major role with respect to Islamist terrorist groups: A role similar to that

played by angry German nationalism with respect to Nazism in the decades after World War I. Not all angry German nationalists became Nazis and not all those schooled in Wahhabi beliefs become terrorists, but in each case the broader doctrine of hatred has provided the soil in which the particular totalitarian movement has grown. Whether in lectures in the madrassas of Pakistan, in textbooks printed by Wahhabis for Indonesian schoolchildren, or on bookshelves of mosques in the United States, the hatred spread by Wahhabis and funded by oil is evident and influential.

On all points except allegiance to the Saudi State, Wahhabi and al-Qaeda beliefs are essentially the same. In this there is another rough parallel to the 1930s—between Wahhabis' attitudes toward al-Qaeda and like-minded Salafist jihadi groups today and Stalinists' attitude toward Trotskyites some 60 years ago. The only difference between Stalinists and Trotskyites was on the question whether allegiance to a single state was required or whether freelance killing of enemies was permitted. But Stalinist hatred of Trotskyites and their free-lancing didn't signify disagreement about underlying objectives, only tactics, and Wahhabi/Saudi cooperation with us in the fight against al-Qaeda doesn't indicate fundamental disagreement between Wahhabis and al-Qaeda on, e.g., their common genocidal fanaticism about Shi'a, Jews, and homosexuals. So Wahhabi teaching basically supports al-Qaeda ideology.

It is sometimes contended that we should not seek substitutes for oil because disruption of the flow of funds to the Greater Middle East could further radicalize the population of some states there. The solution, however, surely lies in helping these states diversify their economies over time, not in perpetually acquiescing to the economic rent they collect from oil exports and to the uses to which these revenues are put.

6. The current account deficits for a number of countries create risks ranging from major world economic disruption to deepening poverty, and could be substantial reduced by reducing oil imports

The United States in essence borrows about $2 billion a day, every day, principally now from major Asian states, to finance its consumption. The single largest category of imports is the approximately $1 billion per working day borrowed to import oil. The accumulating debt increases the risk of a flight from the dollar or major increases in interest rates. Any such development could have major negative economic consequences for both the United States and its trading partners.

For developing nations, the service of debt is a major factor in their continued poverty. For many, debt is heavily driven by the need to import oil that at today's oil prices cannot be paid for by sales of agricultural products, textiles, and other typical developing nation exports.

If such deficits are to be reduced, however, say by domestic production of substitutes for petroleum, this should be based on recognition of real economic value such as waste cleanup, soil replenishment, or other tangible benefits.

7. Global-warming gas emissions from man-made sources create at least the risk of climate change

Although the point is not universally accepted, the weight of scientific opinion suggests that global warming gases produced by human activity form one important component of potential climate change. Oil products used in transportation provide a major share of U.S. man-made global warming gas emissions.

THREE PROPOSED DIRECTIONS FOR POLICY

The above considerations suggest that government policies with respect to the vehicular transportation market should point in the following directions:

1. Encourage improved vehicle mileage, using technology now in production

Three currently available technologies stand out to improve vehicle mileage.

Diesels

First, modern diesel vehicles are coming to be capable of meeting rigorous emission standards (such as Tier 2 standards, being introduced into the United States, 2004–08). In this context it is possible without compromising environmental standards to take advantage of diesels' substantial mileage advantage over gasoline-fueled internal combustion engines.

Substantial penetration of diesels into the private vehicle market in Europe is one major reason why the average fleet mileage of such new vehicles is 42 miles per gallon in Europe and only 24 mpg in the United States. Although the United States has, since 1981, increased vehicle weight by 24 percent and horsepower by 93 percent, it has actually somewhat lost ground with respect to mileage over that near-quarter century, In the 12 years from 1975 to 1987, however, the United States improved the mileage of new vehicles from 15 to 26 mpg.

Hybrid gasoline-electric

Second, hybrid gasoline-electric vehicles now on the market show substantial fuel savings over their conventional counterparts. The National Commission on Energy Policy found that for the four hybrids on the market in December 2004 that had exact counterpart models with conventional gasoline engines, not only were mileage advantages quite significant (10–15 mpg) for the hybrids, but in each case the horsepower of the hybrid was higher than the horsepower of the conventional vehicle.

Light-weight carbon composite construction

Third, constructing vehicles with inexpensive versions of the carbon fiber composites that have been used for years for aircraft construction can substantially reduce vehicle weight and increase fuel efficiency while at the same time making the vehicle considerably safer than with current construction materials. This is set forth thoroughly in the 2004 report of the Rocky Mountain Institute's "Winning the Oil Endgame." Aerodynamic design can have major

importance as well. This breaks the traditional tie between size and safety. Much lighter vehicles, large or small, can be substantially more fuel-efficient and also safer. Such composite use has already been used for automotive construction in Formula 1 race cars and is now being adopted by BMW and other automobile companies. The goal is mass-produced vehicles with 80 percent of the performance of hand-layup aerospace composites at 20 percent of the cost. Such construction is expected to approximately double the efficiency of a normal hybrid vehicle without increasing manufacturing cost.

2. Encourage the commercialization of alternative transportation fuels that can be available soon, are compatible with existing infrastructure, and can be derived from waste or otherwise produced cheaply

Biomass (cellulosic) ethanol

The use of ethanol produced from corn in the United States and sugar cane in Brazil has given birth to the commercialization of an alternative fuel that is coming to show substantial promise, particularly as new feedstocks are developed. Some 6 million vehicles in the United States, and all new vehicles in Brazil other than those that use solely ethanol, are capable of using ethanol in mixtures of up to 85 percent ethanol and 15 percent gasoline (E–85). These are called Flexible Fuel Vehicles (FFV) and require, compared to conventional vehicles, only a somewhat different kind of material for the fuel line and a differently programmed computer chip. The cost of incorporating this feature in new vehicles is trivial. Also, there are no large-scale changes in infrastructure required for ethanol use. It may be shipped in tank cars (and, in Brazil, in pipelines), and mixing it with gasoline is a simple matter.

Although human beings have been producing ethanol, grain alcohol, from sugar and starch for millennia, it is only in recent years that the genetic engineering of biocatalysts has made possible such production from the hemicellulose and cellulose that constitute the substantial majority of the material in most plants. The genetically engineered material is in the biocatalyst only; there is no need for genetically modified plants.

These developments may be compared in importance to the invention of thermal and catalytic cracking of petroleum in the first decades of the 20th century—processes which made it possible to use a very large share of petroleum to make gasoline rather than the tiny share that was available at the beginning of the century. For example, with such genetically engineered biocatalysts it is not only grains of corn but corn cobs and most of the rest of the corn plant that may be used to make ethanol.

Such biomass, or cellulosic, ethanol is now likely to see commercial production begin first in a facility of the Canadian company, Iogen, with backing from Shell Oil, at a cost of around $1.30/gallon. The National Renewable Energy Laboratory estimates costs will drop to around $1.07/gallon over the next 5 years, and the Energy Commission estimates a drop in costs to 67–77 cents/gallon when the process is fully mature. The most common feedstocks will likely

be agricultural wastes, such as rice straw, or natural grasses such as switchgrass, a variety of prairie grass that is often planted on soil bank land to replenish the soil's fertility. There will be decided financial advantages in using as feedstocks any wastes which carry a tipping fee (a negative cost) to finance disposal—e.g., waste paper, or rice straw, which cannot be left in the fields after harvest because of its silicon content.

Old or misstated data are sometimes cited for the proposition that huge amounts of land would have to be introduced into cultivation or taken away from food production in order to have such biomass available for cellulosic ethanol production. This is incorrect. The National Commission on Energy Policy reported in December that, if fleet mileage in the United States rises to 40 mpg—somewhat below the current European Union fleet average for new vehicles of 42 mpg and well below the current Japanese average of 47 mpg—then as switchgrass yields improve modestly to around 10 tons/acre it would take only 30 million acres of land to produce sufficient cellulosic ethanol to fuel half the U.S. passenger fleet. By way of calibration, this would essentially eliminate the need for oil imports for passenger vehicle fuel and would require only the amount of land now in the soil bank (the Conservation Reserve Program (CRP) on which such soil-restoring crops as switchgrass are already being grown. Practically speaking, one would probably use for ethanol production only a little over half of the soil bank lands and add to this some portion of the plants now grown as animal feed crops (for example, on the 70 million acres that now grow soybeans for animal feed). In short, the United States and many other countries should easily find sufficient land available for enough energy crop cultivation to make a substantial dent in oil use.

There is also a common and erroneous impression that ethanol generally requires as much energy to produce as one obtains from using it and that its use does not substantially reduce global warming gas emissions. The production and use of ethanol merely recycles in a different way the CO_2 that has been fixed by plants in the photosynthesis process. It does not release carbon that would otherwise stay stored underground, as occurs with fossil fuel use, but when starch, such as corn, is used for ethanol production much energy, including fossil-fuel energy, is consumed in the process of fertilizing, plowing, and harvesting. Even starch-based ethanol, however, does reduce greenhouse gas emissions by around 30 percent. Because so little energy is required to cultivate crops such as switchgrass for cellulosic ethanol production, and because electricity can be coproduced using the residues of such cellulosic fuel production, reductions in greenhouse gas emissions for celluslosic ethanol when compared to gasoline are greater than 100 percent. The production and use of cellulosic ethanol is, in other words, a carbon sink.

Biodiesel and renewable diesel

The National Commission on Energy Policy pointed out some of the problems with most current biodiesel "produced from rapeseed, soybean, and other vegetable oils—as well as . . . used cooking oils." It said that these are "unlikely to become economic on a large

scale" and that they could "cause problems when used in blends higher than 20 percent in older diesel engines." It added that "waste oil is likely to contain impurities that give rise of undesirable emissions."

The Commission notes, however, that biodiesel is generally "compatible with existing distribution infrastructure" and outlines the potential of a newer process ("thermal depolymerization") that produces renewable diesel without the above disadvantages, from "animal offal, agricultural residues, municipal solid waste, sewage, and old tires." (This has recently been designated "Renewable Diesel" in the Energy Act of this past summer.) The Commission points to the current use of this process at a Conagra turkey processing facility in Carthage, Missouri, where a "20 million commercial-scale facility" is beginning to convert turkey offal into "a variety of useful products, from fertilizer to low-sulfur diesel fuel" at a potential average cost of "about 72 cents per gallon."

Other Alternative Fuels

Progress has been made in recent years on utilizing not only coal but slag from strip mines, via gasification, for conversion into diesel fuel using a modern version of the gasified-coal-to-diesel process used in Germany during World War II.

Qatar has begun a large-scale process of converting natural gas to diesel fuel.

Outside the realm of conventional oil, the tar sands of Alberta and the oil shale of the Western United States exist in huge deposits, the exploitation of which is currently costly and accompanied by major environmental difficulties, but both definitely hold promise for a substantial increase in oil supply.

3. Plug-in hybrids and battery improvements

A modification to hybrids could permit them to become "plug-in-hybrids," drawing power from the electricity grid at night and using all electricity for short trips before they move to operating in their gasoline-electric mode as hybrids. With a plug-in hybrid vehicle one has the advantage of an electric car, but not the disadvantage. Electric cars cannot be recharged if their batteries run down at some spot away from electric power. But since all hybrids have tanks containing liquid fuel plug-in hybrids have no such disadvantage.

The "vast majority of the most fuel-hungry trips are under 6 miles" and "well within the range" of current (nickel-metal hydride) batteries' capacity, according to Huber and Mills ("The Bottomless Well," 2005). Current Toyota Priuses sold in Japan and Europe have a button, that Toyota has removed for some reason on American vehicles, that permits all-electric driving for up to a kilometer; all that is really needed is to equip hybrids with adequate batteries so that this capability can be extended. Over half of all U.S. vehicles are driven less than 30 miles/day, so a plug-in hybrid that can obtain that range might go for many weeks without visiting the gasoline station. Other experts, however, emphasize that whether with existing nickel-metal-hydride battery types or with the more capable lithium-ion batteries now commercially available for computer and other applications, it is important that any battery used

in a plug-in hybrid be capable of taking daily charging without being damaged and be capable of powering the vehicle at an adequate speed and argue that battery development will be necessary in order for this to be the case.

But the California experience with electric vehicles (EVs) in the 1990s suggests otherwise. It demonstrated that batteries used in those vehicles, particularly the nickel-metal-hydride ones that were used in later EV models (some of which are still on the road), have easily shown the capability for being charged daily for a number of years. And at U. Cal. (Davis) Professor Andy Frank has been designing and operating plug-in hybrids for years that now, with commercially available batteries, operate all electrically for 60 miles at up to 60 mph before the hybrid gasoline-electric feature needs to be used. Whether development is needed for some improvements to lithium-ion batteries or only financial incentives for mass production of them or the more mature nickel-metal-hydride batteries, such efforts should have the highest priority because plug-in hybrids promise to revolutionize transportation economics and to have a dramatic effect on the problems caused by oil dependence.

Moreover the attractiveness to the consumer of being able to use electricity from overnight charging for a substantial share of the day's driving is stunning. The average residential price of electricity in the United States is about 8.5 cents/kwh, and many utilities sell off-peak power for 2–4 cents/kwh. When one takes into consideration the different efficiencies of liquid-fueled and electric propulsion, then where the rubber meets the road the cost of powering a plug-in hybrid with average-cost residential electricity would be about 40 percent of the cost of powering the same vehicle with today's approximately $2.50/gallon gasoline, or, said another way, for the consumer to be able to buy fuel in the form of electricity at the equivalent of $1/gallon gasoline. Using off-peak power would then equate to being able to buy 25-to-50 cent/gallon gasoline. Given the burdensome cost imposed by current fuel prices on commuters and others who need to drive substantial distances, the possibility of powering one's family vehicle with fuel that can cost as little as one-tenth of today's gasoline (in the U.S. market) should solve rapidly the question whether there would be public interest in and acceptability of plug-in hybrids.

Although the use of off-peak power for plug-in hybrids should not require substantial new investments in electricity generation for some time (until millions of plug-ins are on the road), greater reliance on electricity for transportation should lead us to look particularly to the security of the electricity grid as well as the fuel we use to generate electricity. In the United States the 2002 report of the National Academies of Science, Engineering, and Medicine ("Making the Nation Safer") emphasized particularly the need to improve the security of transformers and of the Supervisory Control and Data Acquisition (SCADA) systems in the face of terrorist threats. The National Commission on Energy Policy has seconded those concerns. With or without the advent of plug-in hybrids, these electricity grid vulnerabilities require urgent attention.

CONCLUSION

The dangers from oil dependence in today's world require us both to look to ways to reduce demand for oil and to increase supply of transportation fuel by methods beyond the increase of oil production.

The realistic opportunities for reducing demand soon suggest that government policies should encourage hybrid gasoline-electric vehicles, particularly the battery work needed to bring plug-in versions thereof to the market, and modern diesel technology. The realistic opportunities for increasing supply of transportation fuel soon suggest that government policies should encourage the commercialization of alternative fuels that can be used in the existing infrastructure: Cellulosic ethanol and biodiesel/renewable diesel. Both of these fuels could be introduced more quickly and efficiently if they achieve cost advantages from the utilization of waste products as feedstocks.

The effects of these policies are multiplicative. All should be pursued since it is impossible to predict which will be fully successful or at what pace, even though all are today either beginning commercial production or are nearly to that point. The battery development for plug-in hybrids is of substantial importance and should for the time being replace the current r&d emphasis on automotive hydrogen fuel cells.

If even one of these technologies is moved promptly into the market, the reduction in oil dependence could be substantial. If several begin to be successfully introduced into large-scale use, the reduction could be stunning. For example, a 50-mpg hybrid gasoline/electric vehicle, on the road today, if constructed from carbon composites would achieve around 100 mpg. If it were to operate on 85 percent cellulosic ethanol or a similar proportion of biodiesel or renewable diesel fuel, it would be achieving hundreds of miles per gallon of petroleum-derived fuel. If it were a plug-in version operating on either upgraded nickel-metal-hydride or newer lithium-ion batteries so that 30-mile trips or more could be undertaken on its overnight charge before it began utilizing liquid fuel at all, it could be obtaining in the range of 1,000 mpg (of petroleum).

A range of important objectives—economic, geopolitical, environmental—would be served by our embarking on such a path. Of greatest importance, we would be substantially more secure.

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