

EIA 2005 ANNUAL ENERGY OUTLOOK

HEARING
BEFORE THE
COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE
ONE HUNDRED NINTH CONGRESS

FIRST SESSION

TO

RECEIVE TESTIMONY REGARDING GLOBAL ENERGY TRENDS AND
THEIR POTENTIAL IMPACT ON U.S. ENERGY NEEDS, SECURITY, AND
POLICY

FEBRUARY 3, 2005



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EIA 2005 ANNUAL ENERGY OUTLOOK

THURSDAY, FEBRUARY 3, 2005

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The committee met, pursuant to notice, at 10:05 a.m., in room SD-366, Dirksen Senate Office Building, Hon. Pete V. Domenici, chairman, presiding.

OPENING STATEMENT OF HON. PETE V. DOMENICI, U.S. SENATOR FROM NEW MEXICO

The CHAIRMAN. The hearing will please come to order.

First, I want to thank everyone who is here and particularly the Senators who are here. I will be brief and then, of course, any Senators that want to comment, I will be glad to have that occur this morning.

The three questions that we are going to focus on today at this hearing are: first, what are the United States' current and future energy needs? How will they be met, and how will global energy trends impact on the United States?

With demand for energy ever increasing, the need to understand the answers to these three questions seems to me to be critical. In consultation with others, we have decided that we would hear from those either in Government or in the private sector that we thought might shed significant light on these three issues.

For example, in 2004, the United States consumed about 20 million barrels of oil a day. In 2025, the United States is predicted to require 27.9 million barrels a day. What is oil world demand projected to be? And oil demand would increase from about 82 million barrels a day to 121 million barrels a day by 2030. Now, that sounds like a very large increase, but remember, there are large users in the marketplace whose needs are going to increase dramatically also. So will this additional oil be enough for America's economy, and where will it come from? How will it affect the United States' relations with other countries in Asia, the Middle East, Russia, Canada, South America, et cetera?

Our natural gas situation also presents many challenges that need our immediate attention. The U.S. consumption is growing, mainly to meet electricity and industrial application demands. Our production faces a number of constraints, and natural gas importation, which I assume will be discussed here substantially, known as LNG, faces a variety of obstacles. According to the EIA, which is here and going to testify, we are going to go from importing .7 trillion cubic feet of liquefied natural gas to what they estimate to

be 6.4 trillion cubic feet in 2025. Now, that sounds rather incredible, but they will talk about it. I guess we will talk about how we can meet that and what would be needed to do that. That means that we would have a 20-plus increase by 2025.

Our witnesses today will share their perspectives on these challenges and in advance we thank them, both for being here today and for their thoughts.

Now, with that, I would like Senator Bingaman, if he cares to, to make some comments, and then each of the Senators who is here.

Senator Bingaman.

[The prepared statements of Senators Alexander and Feinstein follow:]

STATEMENT OF HON. LAMAR ALEXANDER, U.S. SENATOR FROM TENNESSEE

We live in unprecedented times. If someone from Mars landed in the United States and looked at our energy policy, they would see that it makes no sense. We are a nation at war. We rely on energy from a part of the world that bitterly resents our nation. World energy demand is growing significantly. According to the World Energy Agency, world energy demand is projected to rise by 59 percent from now until the year 2030. Two-thirds of this new demand will come from the developing world, especially from China and India.

China is the driver of world oil demand. Listen to these statistics:

- China is adding the equivalent energy demand of one middle-sized country every two years.
- China aims to quadruple its gross domestic product by 2020. This means that the equivalent of three more economies the size of China could be added in less than two decades.
- About 70 percent of the new power plants being built in the world are being built in China. Last year, China built 37,000 Megawatts of new power—that's the equivalent of American Electric Power, the largest power company in America. And they are still short power—two-thirds of China normally experiences blackouts.
- Last year, China overtook Japan as the second-largest consumer of oil. In 2004, China's fuel demand grew 15 percent.
- China just completed its first LNG terminal and there are potentially nine more in the next few years. We are competing with China for the same LNG supply.

China is going to get its oil from the Middle East and South America—the same places we get our oil. This dynamic will increase the chance of resource conflicts and competition between countries, such as China and the United States. This year's price spikes are partly a result of China's increased thirst for oil.

The challenges here don't stop at the price that we will pay for our gasoline and threatening our manufacturing sector's competitiveness.

Coal supplies about 65 percent of China's energy needs. By 2030, China and India will account for 44 percent of worldwide coal-based electricity generation. We need to commercialize clean coal technology, like coal gasification—not only for use in our country—but in developing countries as well. If the coal plants in China are dirty, then this impacts our air quality in the United States as well.

The growing demand for energy in developing countries underscores that we must get serious about reducing our reliance on foreign oil. We must get serious about talking about conservation—for oil and natural gas. We must get serious about talking about more domestic supply. We must get serious about commercializing clean coal technology. And yes, the United States needs to get serious in doing more on climate change—but so does the developing world.

I look forward to this hearing and learning how we can incorporate this important discussion into the upcoming discussions on the Energy Bill.

STATEMENT OF HON. DIANNE FEINSTEIN, U.S. SENATOR FROM CALIFORNIA

Thank you, Mr. Chairman, for holding this hearing today. The topic of the hearing is of particular interest in light of the increased global demand for energy, which will only continue to grow.

According to the Energy Information Administration, the United States' demand for oil is expected to grow by about 40% by 2025—from 20 million barrels per day to 27.9 million barrels per day. World demand is expected to increase from 49.2 million barrels per day in 2001 to 66.3 million barrels per day in 2025. Much of this growth is due to growing demand for oil in Asia.

I cite these numbers to show that any energy policy considered by this Committee must not be considered in a vacuum. We must recognize the stress on our natural resources and our environment if we continue to implement energy policies that only stress traditional energy sources.

If our goal is to provide our constituents with access to low-cost, reliable energy supplies, any energy policy must include *real* energy efficiency standards and incentives, a robust renewable energy portfolio standard, and aggressive fuel economy standards.

All choices have consequences. If we maintain our current energy use the EIA estimates that carbon dioxide emissions are projected to increase from 5,789 million metric tons in 2003 to 8,062 million metric tons in 2025, an average annual increase of 1.5 percent.

As the world's largest emitter of greenhouse gases, we must act to reduce our emissions, not increase them. While the United States is on a path to increase emissions by 1.5 percent per year, the United Kingdom, a Kyoto signatory, must reduce emissions by 20% by 2010.

The Kyoto Protocol will enter into effect on February 16, 2005. The United States is the only developing nation besides Australia that has not signed onto the treaty. Australia has not signed onto the treaty but is expected to reduce emissions in line with Kyoto.

I am concerned that by the time we recognize that climate change is a problem, it will be too late to change our way of life. I am also worried that our determination to continue the status quo and to forego any action on climate change only further isolates us in the international community.

I look forward to hearing the witnesses' thoughts on our energy future. Thank you Mr. Chairman.

**STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR
FROM NEW MEXICO**

Senator BINGAMAN. Thank you very much, Mr. Chairman. I really appreciate you holding the hearing and appreciate this excellent group of witnesses coming to advise us of their views on future global energy trends. I will just stop with that and wait until the question period. Thank you.

The CHAIRMAN. Thank you.
Senator Martinez.

**STATEMENT OF HON. MEL MARTINEZ, U.S. SENATOR
FROM FLORIDA**

Senator MARTINEZ. Mr. Chairman, thank you again for holding this hearing. As a new committee member, I am looking forward to the hearing. I think it is an important moment for me to learn from the panel, and I look forward to hearing their testimony and then perhaps I will have some questions.

I do believe that I share the concern that we do need to have a comprehensive energy policy, and I look forward with the chairman and the ranking member to move an energy bill this year.

The CHAIRMAN. Thank you very much.
Senator Wyden.

**STATEMENT OF HON. RON WYDEN, U.S. SENATOR
FROM OREGON**

Senator WYDEN. Thank you, Mr. Chairman. I am going to be in and out a bit this morning. I appreciate the chance to make a brief statement.

Mr. Chairman and colleagues, in terms of energy security, I am now convinced that taxpayers are not getting the best bang that they can get for their buck. According to the Congressional Research Service, two of the current tax incentives for oil exploration and production are especially inefficient. These two subsidies cost the taxpayers alone about \$1.3 billion per year, and I would ask, Mr. Chairman, if that Congressional Research analysis could be put into the record at this point.*

The CHAIRMAN. Absolutely.

Senator WYDEN. Mr. Chairman and colleagues, at the same time we are wasting taxpayer funds, our country is not providing enough incentive for oil producers to use enhanced oil recovery techniques that could go a long way toward reducing our Nation's dependence on foreign oil. According to the Congressional Research Service, it is estimated that nearly 400 billion barrels of oil remain in abandoned reserves. The Congressional Research Service also says that 10 percent of that oil consists of known recoverable reserves that could be produced with the proper techniques if the appropriate financial incentives were there.

So according to my math, that is an additional 40 billion barrels of oil that could be produced right here in our Nation. At the current level of about 10 million barrels per day, 40 billion barrels is roughly what the United States will import over the next 10 years.

So I think as we go forward, with respect to this whole discussion, Mr. Chairman and colleagues, we ought to look and look in a bipartisan way at using, particularly, tax incentives that are now in place and are not particularly efficient and reconfigure those incentives so as to increase production.

One last point that I am going to want to explore with Mr. Caruso is that I cannot understand why U.S. oil producers are allowed to pocket more than a billion dollars in subsidies and then are allowed to export more than 1 million barrels of U.S.-produced oil each day. It seems to me that if taxpayers are subsidizing an oil company's production, the United States ought to get to keep that company's oil production in our Nation.

Mr. Chairman, again, I thank you for your thoughtfulness and being able to make this statement. I look forward to working with you and our colleagues.

The CHAIRMAN. Thank you very much, Senator.
Senator Salazar.

**STATEMENT OF HON. KEN SALAZAR, U.S. SENATOR
FROM COLORADO**

Senator SALAZAR. Thank you, Mr. Chairman. I have a statement for the record that I will submit, if there is no objection.

The CHAIRMAN. It will be made a part of the record.

Senator SALAZAR. I want to just make a quick statement. Your forecasts are very important to us and I very much look forward to those forecasts. I have a particular interest in your long-term forecasts on the role that renewable energy can play here in our Nation and in our world. In my own State, we have an abundance of natural resources. We are developing many of those natural re-

*The report (S. Rpt. 108-54) has been retained in committee files.

sources in coal, oil and gas. But we also have a significant initiative underway to move forward with the development of renewable energy, and it would be good to have some good science with respect to where you think the renewable energy component of our whole energy equation is going to go. So I very much look forward to your comments, and thank you.

[The prepared statement of Senator Salazar follows:]

PREPARED STATEMENT OF HON. KEN SALAZAR, U.S. SENATOR FROM COLORADO

Good morning Mr. Chairman, Senator Bingaman, and members of the committee. I would like to welcome our guests who are here today to offer their perspectives on the energy future of the United States and of the world. This Committee will be responsible for many of the decisions that will directly affect that future.

My own state of Colorado contributes substantially to the energy resources of our country. We are blessed with an abundance of natural energy resources, and the oil and gas industry plays a significant part of our state economy. But as long as the United States is dependent on foreign oil for a significant part of our energy needs, our economy and our national security are at risk. We need to move rapidly toward energy independence and energy security.

I am particularly interested in your forecasts with respect to renewable energy sources and the effects of world energy supply and demand on the development of renewable and alternative sources of energy in the United States. And with respect to traditional sources of energy, I hope you will tell us how you think this body can encourage the development of new, cleaner, and more efficient technologies for coal and natural gas.

I note that this year the International Energy Agency (IEA) produced an "Alternative Policy Scenario," which considers the effects of more vigorous government efforts to combat environmental problems and to reduce energy-security risks. According to IEA, under such a scenario energy demand would decrease by 10% in the next 25 years and carbon emissions would decrease by 16%. At the same time, world dependence on the Middle East for supplies of oil and gas would be significantly reduced. These results can be achieved through government policies that encourage more efficient use of energy in vehicles, electric appliances, lighting and industry, as well as a greater emphasis on the use of renewable sources of energy.

I look forward to your testimony.

The CHAIRMAN. Thank you very much, Senator.

Let us proceed then with our witnesses. Are we going to go in this order? All right. The Administrator of the Energy Information Administration from the Department of Energy, Guy Caruso. We will call on you, but I note another Senator arrived. Let us see if he wants to comment.

Senator Smith.

**STATEMENT OF HON. GORDON SMITH, U.S. SENATOR
FROM OREGON**

Senator SMITH. Thank you, Mr. Chairman. If you would like to proceed, I will put mine in the record and just state the summary of what my written statement is.

And that is, from what I read of your testimony, our Nation needs an energy bill. I think President Bush was wise to call on us to pass an energy bill because we are clearly too dependent upon foreign sources. I guess by 2025, according to your testimony, 38 percent of our energy will come from abroad, and that has dire consequences to consumers and to our national security. Specifically natural gas and LNG terminals, we have got to find a way to expand those. If we do not, farmers and all consumers will continue to bear very high prices, and we owe them better than that. We can do better than that.

Without objection, Mr. Chairman, I would like to put this statement in the record.

The CHAIRMAN. Thank you very much. Your statement will be made a part of the record.

[The prepared statement of Senator Smith follows:]

PREPARED STATEMENT OF HON. GORDON SMITH, U.S. SENATOR FROM OREGON

Mr. Chairman, as we begin the debate on national energy policy in the 109th Congress, I appreciate your willingness to schedule this hearing on global energy trends, and their potential impact on this nation's vital energy supplies—particularly oil and natural gas.

The short-term outlook is not good for consumers, as energy prices remain at or near historic highs. While all Americans are feeling the effects on their wallets, high prices harm our financially vulnerable constituents the most. Low-income families and those on fixed incomes should not have to choose between eating and paying their utility bills.

Even more disconcerting are the projections of our growing dependence on imported energy resources. This vulnerability will be exacerbated in the coming decades because the United States will be competing for energy resources against the emerging economies of other nations, particularly China and India.

In its testimony, the Energy Information Agency indicates that net imports of energy are expected to constitute 38 percent of total U.S. energy consumption in 2025, up from 27 percent in 2003. This heavy reliance on imports will deepen our trade deficits, and undercut our economic security. There are also broad foreign policy implications of relying on imported energy resources to sustain our economy.

The EIA now forecasts that, by 2025, the United States will be dependent on imports for 68 percent of its oil and about 22 of its natural gas. Liquefied natural gas will make up an increasing percentage of gas imports as the availability of Canadian gas declines.

There are only four existing U.S. LNG terminals, and three of them are expected to be operating at capacity by 2007. Siting, permitting and constructing new terminals will be expensive, and EIA forecasts that delays and regulatory costs are also expected to add to the price of natural gas for new facilities.

Higher natural gas prices are having impacts throughout our economy. Much of the new electricity generation that has been permitted uses natural gas-fired turbines. Chemical manufacturers need natural gas as an input for manufacturing. Farmers are feeling the effects of higher fertilizer prices, and will continue to bear these costs so long as natural gas prices remaining high. There is strong correlation between the prices of natural gas and nitrogen fertilizer.

As policymakers, we have an obligation to make the difficult choices today to ensure this nation's economic and energy security in the decades ahead. We must strive to put incentives and policies in place that will enable market forces to meet the energy needs of the United States at a reasonable cost. We must encourage increased domestic production, coupled with energy efficiency and conservation, to meet our future energy needs.

I look forward to hearing from the witnesses today, and to working with my colleagues in the weeks and months ahead to enact a responsible energy policy for our nation.

The CHAIRMAN. I thank you for your comments. I failed to mention in my opening remarks—and I probably should have—that last night the President in an address on far-reaching subjects took time out to give us a significant nudge in behalf of what he saw as our country's needs and to get a bipartisan energy bill. I do not think we have had that significant a pressure on the part of the President to the American people as that statement in a State of the Union.

For myself, Senator Bingaman, I was pleased that the President publicly—I do not know if any other President has—mentioned nuclear power. It seems like they all go right up to it and then go off on something else, but at least he mentioned it. I thank you for your support in the past and the committee's and hope you can move on that front also.

Let us go with you, Mr. Caruso, please.

STATEMENT OF GUY CARUSO, ADMINISTRATOR, ENERGY INFORMATION ADMINISTRATION, DEPARTMENT OF ENERGY

Mr. CARUSO. Thank you, Mr. Chairman, and members of the committee. Good morning. I am pleased to be able to present the Energy Information Administration's long-term outlook, which we published in December. I am going to present some trends today which are based on current policies, rules, and regulations. These numbers are essentially where we are headed if we keep on the path we are on. And where we are headed is toward, as has already been mentioned, increased net import dependency.

Our total primary energy consumption is going to increase by about one-third over the next 20 years by 2025, and because demand is increasing more rapidly than domestic supply, imports will meet a growing share of that demand. Net imports are projected to reach 38 percent of total energy by 2025, up from 27 percent today. Although these are primarily petroleum, also natural gas will play an increasingly important role in the imports.

Our demand grows at about one-half the rate of the GDP over the next 20 years, with the strongest growth being in the commercial and transportation sectors. In the commercial sector, particularly electricity for computers and electronic equipment will lead the way. And of course, in transportation, increasing light-duty vehicles and vehicle miles traveled in both vehicles and aircraft will add to this growth.

With respect to oil, our net import dependency will increase from 56 percent last year to about 68 percent in this baseline forecast. Our oil projections do assume oil prices will decline from their current prices to about \$25 by 2010. But we recognize that there is a great deal of uncertainty in that price outlook, and so in our full report, we will show a number of different alternative price cases which reflect the concerns over uncertainty over resources, infrastructure investment, and geopolitical trends.

Our domestic supply will increase slightly over the next several years as deep-water oil in the Gulf of Mexico comes on stream from new discoveries, but even that will not be enough to keep production up, and production by 2025 will be lower than it is today. Therefore, that nearly 8 million barrel a day growth in demand will almost entirely be made up of increased imports, as I mentioned. Indeed, the largest share of that increase will have to come from the area where most of the oil reserves are, and that is the Middle East. And there is limited opportunity to switch out of oil because so much of it is used in the transportation sector, about 70 percent by 2025.

The picture in natural gas, as the chairman mentioned, is moving in that same direction. Net imports are on track to increase sharply during the next 20 years, mainly in the form of liquified natural gas, LNG. Demand for natural gas will increase by about 40 percent, mainly for electric power generation and industrial use. That is more than 8.5 tcf of growth over this 20-year period. And our domestic supply will not keep pace, not nearly, going only from about 19 tcf to less than 22 by 2025, so that 6.5 additional trillion cubic feet of gas will need to be imported, and that will be almost

all in the form of LNG. As the chairman mentioned, we look for about 6.4 tcf of LNG imports by 2025.

We were relying on Canada for much of our imports in the 1990's. That will no longer be available to us, as Canada's depletion rates increase and their need for domestic use of natural gas as well increases.

For electricity, both natural gas and coal will increase. Coal will maintain its share, about 50 percent of our electric power generation under this scenario. Natural gas will grow rapidly from 16 percent to about 24 percent of our electric power generation. Nuclear generating capacity will increase, but under the existing economics, we do not foresee any new nuclear plants built. Certainly renewables will grow, but their share will stay at about 9 percent of our electric power generation by 2025.

The CHAIRMAN. Included in that word "renewable" is hydro?

Mr. CARUSO. Yes.

The CHAIRMAN. How much of that 9 is hydro?

Mr. CARUSO. Of the 9 percent, 7 percent is hydro.

The CHAIRMAN. So it will be 2 percent from other than hydro?

Mr. CARUSO. That is correct, Senator.

Turning to the global market, world energy consumption is expected to grow even faster at about 54 percent over the next 20 years, and the most rapid growth will be in developing countries, particularly developing Asia. China, for example, will have triple the growth rate as the industrialized countries and the developing countries of Asia will double their consumption of energy in 20 years.

Natural gas will also grow outside of the United States, particularly for electric power generation, but coal will remain the dominant source of electric power generation in developing countries, particularly in China and India, which has important implications for carbon dioxide emissions.

In summary, Mr. Chairman, the economic growth in the populous countries of the world, the United States, China, India, will increase energy demand, and fossil fuels, under the business-as-usual case I presented here, will remain the dominant source of energy. And dependence on foreign sources of oil and increasingly natural gas are expected to increase significantly not only in this country but in China, India, and elsewhere in Asia. This has a very important geopolitical implications, which I am sure we will hear from the following witnesses in more detail.

Mr. Chairman, members of the committee, thank you once again for allowing me to present the EIA's latest outlook. I look forward to the question and answer period. Thank you.

[The prepared statement of Mr. Caruso follows:]

PREPARED STATEMENT OF GUY CARUSO, ADMINISTRATOR, ENERGY INFORMATION
ADMINISTRATION, DEPARTMENT OF ENERGY

U.S. ENERGY PRICES

In the *AEO2005* reference case, the annual average world oil price¹ increases from \$27.73 per barrel (2003 dollars) in 2003 (\$4.64 per million Btu) to \$35.00 per barrel

¹ World oil prices in *AEO2005* are defined based on the average refiner acquisition cost of imported oil to the United States (IRAC). The IRAC price tends to be a few dollars less than the widely-cited West Texas Intermediate (WTI) spot price and has been as much as six dollars per

in 2004 (\$5.86 per million Btu) and then declines to \$25.00 per barrel in 2010 (\$4.18 per million Btu) as new supplies enter the market. It then rises slowly to \$30.31 per barrel in 2025 (\$5.07 per million Btu) [Figure 1]* In nominal dollars, the average world oil price is about \$52 per barrel in 2025 (\$8.70 per million Btu).

There is a great deal of uncertainty about the size and availability of crude oil resources, particularly conventional resources, the adequacy of investment capital, and geopolitical trends. For example, the *AEO2005* reference case assumes that world crude oil prices will decline as growth in consumption slows and producers increase their productive capacity and output in response to current high prices; however, the October 2004 oil futures prices for West Texas Intermediate crude oil (WTI) on the New York Mercantile Exchange (NYMEX) implies that the average annual oil price in 2005 will exceed its 2004 level before falling back somewhat, to levels that still would be above those projected in the reference case. To evaluate this uncertainty about world crude oil prices, the complete *AEO2005* will include other cases based on alternative world crude oil prices paths.

In the *AEO2005*, average wellhead prices for natural gas in the United States are projected to decrease from \$4.98 per thousand cubic feet (2003 dollars) in 2003 (\$4.84 per million Btu) to \$3.64 per thousand cubic feet in 2010 (\$3.54 per million Btu) as the availability of new import sources and increased drilling expands available supply. After 2010, wellhead prices are projected to increase gradually, reaching \$4.79 per thousand cubic feet in 2025 (\$4.67 per million Btu) (about \$8.20 per thousand cubic feet or \$7.95 per million Btu in nominal dollars). Growth in liquefied natural gas (LNG) imports, Alaska production, and lower-48 production from non-conventional sources is not expected to increase sufficiently to offset the impacts of resource depletion and increased demand in the lower 48 states.

In *AEO2005*, the combination of more moderate increases in coal production, expected improvements in mine productivity, and a continuing shift to low-cost coal from the Powder River Basin in Wyoming leads to a gradual decline in the average Monmouth price, to approximately \$17 per ton (2003 dollars) shortly after 2010 (\$0.86 per million Btu). The price is projected to remain nearly constant between 2010 and 2020, increasing after 2020 as rising natural gas prices and the need for baseload generating capacity lead to the construction of many new coal-fired generating plants. By 2025, the average Monmouth price is projected to be \$18.26 per ton (\$0.91 per million Btu). The *AEO2005* projection is equivalent to an average Monmouth coal price of \$31.25 per ton in nominal dollars in 2025 (\$1.56 per million Btu).

Mr. Chairman and Members of the Committee: I appreciate the opportunity to appear before you today to discuss the long-term outlook for energy markets in the United States and for the world.

The Energy Information Administration (EIA) is an independent statistical and analytical agency within the Department of Energy. We are charged with providing objective, timely, and relevant data, analysis, and projections for the use of the Department of Energy, other government agencies, the U.S. Congress, and the public. We do not take positions on policy issues, but we do produce data and analysis reports that are meant to help policy makers in their energy policy deliberations. Because we have an element of statutory independence with respect to the analyses, our views are strictly those of EIA and should not be construed as representing those of the Department, the Administration, or any other organization. However, EIA's baseline projections on energy trends are widely used by government agencies, the private sector, and academia for their own energy analyses.

The *Annual Energy Outlook* provides projections and analysis of domestic energy consumption, supply, prices, and energy-related carbon dioxide emissions through 2025. *Annual Energy Outlook 2005 (AEO2005)* is based on Federal and State laws and regulations in effect on October 31, 2004. The potential impacts of pending or proposed legislation, regulations, and standards—or of sections of legislation that have been enacted but that require funds or implementing regulations that have not been provided or specified—are not reflected in the projections. *AEO2005* explicitly includes the impact of the recently enacted American Jobs Creation Act of 2004, the Military Construction Appropriations Act for Fiscal Year 2005, and the Working Families Tax Relief Act of 2004. *AEO2005* does not include the potential impact of proposed regulations such as the Environmental Protection Agency's (EPA) Clean Air Interstate and Clean Air Mercury rules.

barrel lower than the WTI in recent months. For the first 11 months of 2004, WTI averaged \$41.31 per barrel (\$7.12 per million Btu), while IRAC averaged \$36.28 per barrel (nominal dollars) (\$6.26 per million Btu).

* Figures 1-16 have been retained in committee files.

The U.S. projections in this testimony are based on the December 2004 “early release” of the *AEO2005*. The entire publication will be released later this month. In addition to the long-term U.S. forecast of energy markets, EIA also prepares a long-term outlook for world energy markets, which is published annually in the *International Energy Outlook (IEO)*. The latest edition of this report, the *IEO2004*, was published in April 2004. These projections are not meant to be an exact prediction of the future, but represent a likely energy future, given technological and demographic trends, current laws and regulations, and consumer behavior as derived from known data. EIA recognizes that projections of energy markets are highly uncertain and subject to many random events that cannot be foreseen such as weather, political disruptions, and technological breakthroughs. In addition to these phenomena, long-term trends in technology development, demographics, economic growth, and energy resources may evolve along a different path than expected in the projections. Both the full *AEO2005* and the *IEO2004* include a large number of alternative cases intended to examine these uncertainties. *AEO2005* and *IEO2004* provide integrated projections of U.S. and world energy market trends for roughly the next two decades. The following discussion summarizes the highlights from *AEO2005* for the major categories of U.S. energy prices, demand, and supply. It is followed by a discussion of the key trends in world energy markets projected in *IEO2004*.

Average delivered electricity prices are projected to decline from 7.4 cents per kilowatthour (2003 dollars) in 2003 (\$21.68 per million Btu) to a low of 6.6 cents per kilowatthour in 2011 (\$19.34 per million Btu) as a result of an increasingly competitive generation market and a decline in natural gas prices. After 2011, average real electricity prices are projected to increase, reaching 7.3 cents per kilowatthour in 2025 (\$21.38 per million Btu) (equivalent to 12.5 cents per kilowatthour or \$36.61 per million Btu in nominal dollars).

U.S. ENERGY CONSUMPTION

Total energy consumption is projected to grow at about one-half the rate (1.4 percent per year) of gross domestic product (GDP) with the strongest growth in energy consumption for electricity generation and commercial and transportation uses. Delivered residential energy consumption is projected to grow from 11.6 quadrillion British thermal units (Btu) in 2003 to 14.3 quadrillion Btu in 2025 (0.9 percent per year) [Figure 2]. This growth is consistent with population growth and household formation. The most rapid growth in residential energy demand in *AEO2005* is projected to be in the demand for electricity used to power computers, electronic equipment, and appliances. Delivered commercial energy consumption is projected to grow at a more rapid average annual rate of 1.9 percent between 2003 and 2025, reaching 12.5 quadrillion Btu in 2025, consistent with growth in commercial floorspace. The most rapid increase in commercial energy demand is projected for electricity used for computers, office equipment, telecommunications, and miscellaneous small appliances.

Delivered industrial energy consumption in *AEO2005* is projected to reach 30.8 quadrillion Btu in 2025, growing at an average rate of 1.0 percent per year between 2003 and 2025, as efficiency improvements in the use of energy only partially offset the impact of growth in manufacturing output. Transportation energy demand is expected to increase from 27.1 quadrillion Btu in 2003 to 40.0 quadrillion Btu in 2025, a growth rate of 1.8 percent per year. The largest demand growth occurs in light-duty vehicles and accounts for about 60 percent of the total increase in transportation energy demand by 2025, followed by heavy truck travel (12 percent of total growth) and air travel (12 percent of total growth).

Total petroleum demand is projected to grow at an average annual rate of 1.5 percent in the *AEO2005* forecast, from 20.0 million barrels per day in 2003 to 27.9 million barrels per day in 2025 [Figure 3] led by growth in transportation uses, which account for 67 percent of total petroleum demand in 2003, increasing to 71 percent in 2025. Improvements in the efficiency of vehicles, planes, and ships are more than offset by growth in travel.

Total demand for natural gas is also projected to increase at an average annual rate of 1.5 percent from 2003 to 2025. About 75 percent of the growth in gas demand from 2003 to 2025 results from increased use in power generation and in industrial applications.

Total coal consumption is projected to increase from 1,095 million short tons in 2003 to 1,508 million short tons in 2025, growing by 1.5 percent per year. About 90 percent of the coal is currently used for electricity generation. Coal remains the primary fuel for generation and its share of generation is expected to remain about 50 percent between 2003 and 2025. Total coal consumption for electricity generation

is projected to increase by an average of 1.6 percent per year, from 1,004 million short tons in 2003 to 1,425 million short tons in 2025.

Total electricity consumption, including both purchases from electric power producers and on-site generation, is projected to grow from 3,657 billion kilowatthours in 2003 to 5,467 billion kilowatthours in 2025, increasing at an average rate of 1.8 percent per year. Rapid growth in electricity use for computers, office equipment, and a variety of electrical appliances in the end-use sectors is partially offset in the *AEO2005* forecast by improved efficiency in these and other, more traditional electrical applications and by slower growth in electricity demand in the industrial sector.

Total marketed renewable fuel consumption, including ethanol for gasoline blending, is projected to grow by 1.5 percent per year in *AEO2005*, from 6.1 quadrillion Btu in 2003 to 8.5 quadrillion Btu in 2025, as a result of State mandates for renewable electricity generation and the effect of production tax credits. About 60 percent of the projected demand for renewables in 2025 is for grid-related electricity generation (including combined heat and power), and the rest is for dispersed heating and cooling, industrial uses, and fuel blending.

U.S. ENERGY INTENSITY

Energy intensity, as measured by primary energy use per dollar of GDP (2000 dollars), is projected to decline at an average annual rate of 1.6 percent in the *AEO2005*, with efficiency gains and structural shifts in the economy offsetting growth in demand for energy services [Figure 4]. The projected rate of energy intensity decline in *AEO2005* falls between the historical averages of 2.3 percent per year from 1970 to 1986, when energy prices increased in real terms, and 0.7 percent per year from 1986 to 1992, when energy prices were generally falling. Between 1992 and 2003, energy intensity has declined on average by 1.9 percent per year. During this period, the role of energy-intensive industries in the U.S. economy fell sharply. Energy-intensive industries' share of industrial output declined 1.3 percent per year from 1992 to 2003. In the *AEO2005* forecast, the energy-intensive industries' share of total industrial output is projected to continue declining but at a slower rate of 0.8 percent per year, which leads to the projected slower annual rate of reduction in energy intensity.

Historically, energy use per person has varied over time with the level of economic growth, weather conditions, and energy prices, among many other factors. During the late 1970s and early 1980s, energy consumption per capita fell in response to high energy prices and weak economic growth. Starting in the late 1980s and lasting through the mid-1990s, energy consumption per capita increased with declining energy prices and strong economic growth. Per capita energy use is projected to increase in *AEO2005*, with growth in demand for energy services only partially offset by efficiency gains. Per capita energy use is expected to increase by an average of 0.5 percent per year between 2003 and 2025 in *AEO2005*.

U.S. ENERGY PRODUCTION AND IMPORTS

Total energy consumption is expected to increase more rapidly than domestic energy supply through 2025. As a result, net imports of energy are projected to meet a growing share of energy demand. Net imports are expected to constitute 38 percent of total U.S. energy consumption in 2025, up from 27 percent in 2003 [Figure 5].

Petroleum. Projected U.S. crude oil production increases from 5.7 million barrels per day in 2003 to a peak of 6.2 million barrels per day in 2009 as a result of increased production offshore, predominantly in the deep waters of the Gulf of Mexico. Beginning in 2010, U.S. crude oil production is expected to start declining, falling to 4.7 million barrels per day in 2025. Total domestic petroleum supply (crude oil, natural gas plant liquids, refinery processing gains, and other refinery inputs) follows the same pattern as crude oil production in the *AEO2005* forecast, increasing from 9.1 million barrels per day in 2003 to a peak of 9.8 million barrels per day in 2009, then declining to 8.8 million barrels per day in 2025 [Figure 6].

In 2025, net petroleum imports, including both crude oil and refined products (on the basis of barrels per day), are expected to account for 68 percent of demand, up from 56 percent in 2003. Despite an expected increase in domestic refinery distillation capacity, net refined petroleum product imports account for a growing proportion of total net imports, increasing from 14 percent in 2003 to 16 percent in 2025.

Natural Gas. Domestic natural gas production is projected to increase from 19.1 trillion cubic feet in 2003 to 21.8 trillion cubic feet in 2025 in *AEO2005* [Figure 7]. Lower 48 onshore natural gas production is projected to increase from 13.9 trillion cubic feet in 2003 to a peak of 15.7 trillion cubic feet in 2012 before falling to 14.7

trillion cubic feet in 2025. Lower 48 offshore production, which was 4.7 trillion cubic feet in 2003, is projected to increase in the near term (to 5.3 trillion cubic feet by 2014) because of the expected development of some large deepwater fields, including Mad Dog, Entrada, and Thunder Horse. After 2014, offshore production is projected to decline to about 4.9 trillion cubic feet in 2025.

Growth in U.S. natural gas supplies will depend on unconventional domestic production, natural gas from Alaska, and imports of LNG. Total nonassociated unconventional natural gas production is projected to grow from 6.6 trillion cubic feet in 2003 to 8.6 trillion cubic feet in 2025. With completion of an Alaskan natural gas pipeline in 2016, total Alaskan production is projected to increase from 0.4 trillion cubic feet in 2003 to 2.2 trillion cubic feet in 2025.

Three of the four existing U.S. LNG terminals (Cove Point, Maryland; Elba Island, Georgia; and Lake Charles, Louisiana) are all expected to expand by 2007, and additional facilities are expected to be built in the lower-48 States, serving the Gulf, Mid-Atlantic, and South Atlantic States, including a new facility in the Bahamas serving Florida via a pipeline. Another facility is projected to be built in Baja California, Mexico, serving a portion of the California market. Total net LNG imports in the United States and the Bahamas are projected to increase from 0.4 trillion cubic feet in 2003 to 6.4 trillion cubic feet in 2025.

Net Canadian imports are expected to decline from 2003 levels of 3.1 trillion cubic feet to about 2.5 trillion cubic feet by 2009. After 2010, Canadian natural gas imports in *AEO2005* increase to 3.0 trillion cubic feet in 2015 as a result of rising natural gas prices, the introduction of gas from the Mackenzie Delta, and increased production from coalbeds. After 2015, because of reserve depletion effects and growing domestic demand in Canada, net U.S. imports are projected to decline to 2.6 trillion cubic feet in 2025.

Coal. As domestic coal demand grows in *AEO2005*, U.S. coal production is projected to increase at an average rate of 1.5 percent per year, from 1,083 million short tons in 2003 to 1,488 million short tons in 2025. Production from mines west of the Mississippi River is expected to provide the largest share of the incremental coal production. In 2025, nearly two-thirds of coal production is projected to originate from the western States [Figure 8].

U.S. ELECTRICITY GENERATION

In *AEO2005*, generation from both natural gas and coal is projected to increase through 2025 to meet growing demand for electricity. *AEO2005* projects that 1,406 billion kilowatthours of electricity (including generation in the end-use sectors) will be generated from natural gas in 2025, more than twice the 2003 level of about 630 billion kilowatthours [Figure 9]. The natural gas share of electricity generation is projected to increase from 16 percent in 2003 to 24 percent in 2025. Generation from coal is projected to grow from about 1,970 billion kilowatthours in 2003 to 2,890 billion kilowatthours in 2025, with the share decreasing slightly from 51 percent in 2003 to 50 percent in 2025. Between 2004 and 2025, *AEO2005* projects that 87 gigawatts of new coal-fired generating capacity will be constructed.

Nuclear generating capacity in the *AEO2005* is projected to increase from 99.2 gigawatts in 2003 to 102.7 gigawatts in 2025 as a result of uprates of existing plants between 2003 and 2025. All existing nuclear plants are projected to continue to operate, but EIA projects that no new plants will become operational between 2003 and 2025. Total nuclear generation is projected to grow from 764 billion kilowatthours in 2003 to 830 billion kilowatthours in 2025 in *AEO2005*. The share of electricity generated from nuclear is projected to decline from 20 percent in 2003 to 14 percent in 2025.

Renewable technologies are projected to grow slowly because they are relatively capital intensive and they do not compete broadly with traditional fossil-fired generation. Where enacted, State renewable portfolio standards, which specify a minimum share of generation or sales from renewable sources, are included in the forecast. *AEO2005* includes the extension of the Federal production tax credit for wind and biomass through December 31, 2005, as indicated in H.R. 1308, the Working Families Tax Relief Act of 2004. Total renewable generation in *AEO2005*, including combined heat and power generation, is projected to increase from 359 billion kilowatthours in 2003 to 489 billion kilowatthours in 2025, increasing 1.4 percent per year.

U.S. CARBON DIOXIDE EMISSIONS

Carbon dioxide emissions from energy use are projected to increase from 5,789 million metric tons in 2003 to 8,062 million metric tons in 2025 in *AEO2005*, an average annual increase of 1.5 percent [Figure 10]. The carbon dioxide emissions in-

tensity of the U.S. economy is projected to fall from 558 metric tons per million dollars of GDP in 2003 to 397 metric tons per million dollars of GDP in 2025, an average decline of 1.5 percent per year. Projected increases in carbon dioxide emissions primarily result from continued reliance on coal for electricity generation and on petroleum fuels in the transportation sector.

THE INTERNATIONAL OUTLOOK TO 2025

IEO2004 includes projections of regional energy consumption, energy consumption by primary fuel, electricity consumption, carbon dioxide emissions, nuclear generating capacity, and international coal trade flows. World oil production and natural gas production forecasts are also included in the report. The *IEO2004* projects strong growth for worldwide energy demand over the projection period ending in 2025. Total world consumption of marketed energy is expected to expand by 54 percent, from 404 quadrillion Btu in 2001 to 623 quadrillion Btu in 2025 [Figure 11].

World Energy Consumption by Region. The *IEO2004* reference case outlook shows strongest growth in energy consumption among the developing nations of the world [Figure 12]. The fastest growth is projected for the nations of developing Asia, including China and India, where robust economic growth accompanies the increase in energy consumption over the forecast period. GDP in developing Asia is expected to expand at an average annual rate of 5.1 percent, compared with 3.0 percent per year for the world as a whole. With such strong growth in GDP, demand for energy in developing Asia is projected to double over the forecast, accounting for 40 percent of the total projected increment in world energy consumption and 70 percent of the increment for the developing world alone. Energy demand increases by 3.0 percent per year in developing Asia as a whole and by 3.5 percent per year in China and 3.2 percent per year in India.

Developing world energy demand is projected to rise strongly outside of Asia, as well. In the Middle East, energy use increases by an average of 2.1 percent per year between 2001 and 2025; 2.3 percent per year in Africa, and 2.4 percent per year in Central and South America.

In contrast to the developing world, slower growth in energy demand is projected for the industrialized world, averaging 1.2 percent per year over the forecast period. Generally, the nations of the industrialized world can be characterized as mature energy consumers with comparatively slow population growth. Gains in energy efficiency and movement away from energy-intensive manufacturing to service industries result in the lower growth in energy consumption. In the transitional economies of Eastern Europe and the former Soviet Union (EE/FSU) energy demand is projected to grow by 1.5 percent per year in the *IEO2004* reference case. Slow or declining population growth in this region, combined with strong projected gains in energy efficiency as old, inefficient equipment is replaced, leads to the projection of more modest growth in energy use than in the developing world.

World Energy Consumption by Energy Source. Oil continues to be the world's dominant energy source. Oil's share of world energy remains unchanged at 39 percent over the forecast period. China and the other countries of developing Asia account for much of the increase in oil use in the developing world and, indeed, in the world as a whole [Figure 13]. Developing Asia oil consumption is expected to grow from 14.8 million barrels per day in 2001 to 31.6 million barrels per day in 2025, an increase of 16.9 million barrels per day, representing 63 percent of the increment in oil use in the developing world and 39 percent of the total world increment in oil use over the forecast period. In the industrialized world, increases in oil use are projected primarily in the transportation sector. In the developing world, demand for oil increases for all end uses, as countries replace non-marketed fuels used for home heating and cooking with diesel generators and for industrial petroleum feedstocks.

Natural gas demand is projected to show an average annual growth of 2.2 percent over the forecast period [Figure 14]. Gas is seen as a desirable option for electricity, given its efficiency relative to other energy sources and the fact that it burns more cleanly than either coal or oil. The most robust growth in gas demand is expected among the nations of the developing world, where overall demand is expected to grow by 2.9 percent per year from 2001 to 2025 in the reference case. In the industrialized world, where natural gas markets are more mature, consumption of natural gas is expected to increase by an average of 1.8 percent per year over that same time period, with the largest increment projected for North America at 12.9 trillion cubic feet. China and the other nations of developing Asia are expected to see among the fastest growth in gas use worldwide, increasing by 3.5 percent per year between 2001 and 2025.

Coal remains an important fuel in the world's electricity markets and is expected to continue to dominate fuel markets in developing Asia. Worldwide, coal use is expected to grow slowly, averaging 1.5 percent per year between 2001 and 2025 [Figure 15]. In the developing world, coal increases by 2.5 percent per year and will surpass coal use in the rest of the world (the industrialized world and the EE/FSU combined) by 2015. Coal continues to dominate energy markets in China and India, owing to the countries' large coal reserves and limited access to other sources of energy. China and India account for 67 percent of the total expected increase in coal use worldwide (on a Btu basis). Coal use is projected to increase in all regions of the world except for Western Europe and the EE/FSU (excluding Russia), where coal is projected to be displaced by natural gas and, in the case of France, nuclear power for electric power generation.

The highest growth in *nuclear* generation is expected for the developing world, where consumption of electricity from nuclear power is projected to increase by 4.1 percent per year between 2001 and 2025. Developing Asia, in particular, is expected to see the largest increment in installed nuclear generating capacity over the forecast, accounting for 96 percent of the total increase in nuclear power capacity for the developing world as a whole.

Consumption of *electricity from hydropower and other renewable energy sources* is expected to grow by 1.9 percent per year over the projection period. Much of the growth in renewable energy use is expected to result from large-scale hydroelectric power projects in the developing world, particularly among the nations of developing Asia.

World Carbon Dioxide Emissions. In the *IEO2004* reference case, world carbon dioxide emissions are projected to rise from 23.9 billion metric tons in 2001 to 27.7 billion metric tons in 2010 and 37.1 billion metric tons in 2025 [Figure 16].

Much of the projected increase in carbon dioxide emissions is expected in the developing world, accompanying the large increases in energy use projected for the region's emerging economies. Developing countries account for 61 percent of the projected increment in carbon dioxide emissions between 2001 and 2025. Continued heavy reliance on coal and other fossil fuels, as projected for the developing countries, would ensure that even if the industrialized world undertook efforts to reduce carbon dioxide emissions, there still would be substantial increases in worldwide carbon dioxide emissions over the forecast horizon.

CONCLUSIONS

Continuing economic growth in populous countries of the world, such as China, India, and the United States, is expected to stimulate more energy demand, with fossil fuels remaining the dominant source of energy. Dependence on foreign sources of oil is expected to increase significantly for China, India, and the United States. These three countries alone account for 45 percent of the world increase in projected oil demand over the 2001 to 2025 time frame. A key source of this oil is expected to be the Middle East.

Furthermore, although natural gas production is expected to increase, natural gas imports in these three countries are expected to grow faster. In 2001, India and China produced sufficient natural gas to meet domestic demand, but by 2025, gas production in these two countries will only account for around 60 percent of demand. In the United States, reliance on domestic gas supply to meet demand falls from 86 percent to 72 percent over the projection period. The growing dependence on imports in these three countries occurs despite efficiency improvements in both the consumption and the production of natural gas.

This concludes my testimony, Mr. Chairman and members of the Committee. I will be happy to answer any questions you may have.

The CHAIRMAN. Well, thank you, Mr. Caruso. I want to take this opportunity to say to you, and through you, to all those who work for you, it used to be, 10 years or so ago, we did not know whether we believed you all, but you have become a very formidable organization. And we are glad to have you and we have great trust in what you tell us. So we hope you will keep the professionalism up because you are pretty important to us.

Mr. CARUSO. Well, as I promised to then Chairman Bingaman, I would do my best to keep EIA a strong and independent organization, and I hope I have been able to achieve that. Thank you, Senator.

The CHAIRMAN. Thank you.
 Our next witness is Jeffrey Logan, China Program Manager, International Energy Agency. Why do we have you here today?
 [Laughter.]

**STATEMENT OF JEFFREY LOGAN, SENIOR ENERGY ANALYST
 AND CHINA PROGRAM MANAGER, INTERNATIONAL ENERGY
 AGENCY**

Mr. LOGAN. That is a very good question, Mr. Chairman.

The CHAIRMAN. No. I mean China must be important. Right? That is why we have you here?

Mr. LOGAN. Originally the IEA planned to send someone—

The CHAIRMAN. I did not mean you personally. I mean the issue. I like you. You are fine.

[Laughter.]

Mr. LOGAN. Thank you, Mr. Chairman and members of the committee.

The IEA is very appreciative of the chance to testify here this morning about China's energy sector. What I hope to primarily discuss this morning are the oil and gas sectors in China. Clearly there are many other topics in the Chinese energy sector that are vitally important to the global energy sector, but I would like to restrict most of my remarks to those topics. And I would be happy to try to answer any questions you might have on other topics.

But before I begin with oil and gas issues, I would like to say just a few words about a more general energy trend in China that could have very important long-term implications, and that general energy trend is related to the amount of energy that is needed to drive economic growth in China.

From 1979 until the late 1990's, China's average reported energy consumption grew only half as quickly as the rate of GDP. This is called the energy elasticity. In other words, the energy elasticity was 0.5. For every 1 percent growth in GDP, the energy consumption would grow by .5 percent. So I think there remains a healthy degree of skepticism about energy and economics statistics that are published by China, but even taking those uncertainties into account, the energy elasticity in China is still below 1.0, meaning that the energy growth rate was not exceeding the growth rate of GDP. For a developing country, this was a remarkable achievement, and it resulted in significant savings of both energy consumption and greenhouse gas emissions.

However, since the new millennium has begun, energy consumption in China has surged and the elasticity in 2004, for example, was 1.5, meaning that for every 1 percent growth in GDP, energy consumption was now growing by 1.5 percent. Still, there are some data uncertainties related to these numbers, but the general trend is clearly visible.

No one, as of yet, has come up with a sufficiently satisfactory answer for why this sudden change has happened in the Chinese energy-economic relationship, and we think it is vitally important that we understand why over the past 5 years, the Chinese economy has been consuming so much more energy to drive its economy. Indeed, this changing energy-economic relationship in China caught many Chinese planners off guard and largely explains the

very severe shortages that exist in many of the energy sectors in China right now.

This change in behavior could be just a short-term phenomenon, but the impact of such a change over a longer period of time would have very profound impacts on global markets, energy security, and greenhouse gas emissions. So I think we should strive to more fully understand just what is happening in China's economy right now because it will have long-term implications for everyone on the globe.

China's opaque oil sector has attracted immense attention over the past few years. Oil demand in China grew by 27 percent over the past 2 years, while domestic production has been largely stagnant. As a result, crude imports have climbed by 75 percent since 2002. China now relies on imported crude for 4 of every 10 barrels it consumes. Perhaps surprisingly, China's oil demand in 2004 still only equalled one-third the level of consumption in the United States. IEA forecasts envision Chinese demand to continue growing through the year 2030 when it reaches nearly 14 million barrels per day. At that time, Chinese crude imports would roughly equal those of the United States today. Still, total Chinese demand then would be about one-third less than what the United States consumes right now.

Three drivers account for much of the recent growth in China's oil sector: increasing vehicle ownership, which we have all heard about, the growing industrial demand for petrochemical feedstocks, and most unusually, the surge in oil-fired backup power generation that is needed due to severe electricity generating shortages in China right now.

The vehicle and petrochemical sectors are likely to continue growing steadily in the future, but we anticipate a fall-off in the amount of oil that is needed for this backup power generation using oil as more coal and hydroelectric plants come on line.

Now, as this oil demand falls off the from power generation sector, we do anticipate that some of that will be replaced by the stockpiling of oil in China in the strategic petroleum reserves which they are now developing, but we believe that those amounts put into the stockpile will be less than what is currently being assumed for power generation using oil.

Rising imports in China have alarmed government policymakers.

The CHAIRMAN. Where do they put their petroleum reserve? What is it?

Mr. LOGAN. They have just started construction of their strategic petroleum reserves. There are four sites where they are building the reserves. Currently only the Chinese oil companies hold commercial stockpiles, but not strategic government stockpiles. Those government stockpiles will begin being filled later this year.

The CHAIRMAN. I mean how do they do it. We know what we do. What do they do?

Mr. LOGAN. Above-ground steel tanks.

Rising imports in China have alarmed government policymakers. They have developed a multi-pronged approach to help address the country's looming oil insecurity. The measures include promoting state-owned oil companies to purchase overseas equity oil, diversifying sources of oil supply, launching construction of strategic pe-

troleum reserves, and enacting demand-side efficiency measures. I have outlined each of these measures in my written testimony.

The IEA continues to believe that global oil reserves are sufficient to accommodate global demand through 2030 and beyond. More important uncertainties relate to maintaining stable output among major producers, dealing with environmental issues like climate change, and marshalling the necessary investment in each link of the oil supply chain.

China has taken major steps to boost the use of natural gas, primarily to improve urban air quality, but China's natural gas policy is fragmentary and development occurs on a project-by-project basis rather than by focusing on the needs of the entire gas chain.

But developments in China's gas sector have surprised many critics. The first gas pipeline to Beijing in the late 1990's was widely predicted to be an economic failure, the main criticism being that the government focused only on a supply push strategy and seemed to ignore the needs of potential end-use consumers. Gas demand has developed fairly quickly, however, and a second pipeline to Beijing is now under development.

The new cross-country west-east pipeline faces similar criticism. Potential users have little incentive to switch from coal. The pipeline started commercial operation in late 2004, 1 year ahead of schedule, and will slowly ramp up to design capacity in 2007. The pipeline faces potential competition from imported LNG in cities like Shanghai, and it will be very interesting to see how the competition between pipeline gas and LNG imports develops in China.

In my mind, promoting natural gas use in China is the most cost-effective supply side measure to simultaneously eliminate local pollution, slash greenhouse gas emissions, and promote efficient industrial technology use. U.S. assistance to China focusing on natural gas policy, project development, and capacity building would advance our mutual interests.

In conclusion, although Chinese energy companies will face increasing challenges in global energy markets, they have demonstrated a growing capacity to compete. More than ever, U.S. policies should be focused on engaging China on energy issues because the security, commercial, and environmental implications are too great to ignore.

Thank you for your attention, and I would be happy to take any questions you might have.

[The prepared statement of Mr. Logan follows:]

PREPARED STATEMENT OF JEFFREY LOGAN, SENIOR ENERGY ANALYST AND
CHINA PROGRAM MANAGER, INTERNATIONAL ENERGY AGENCY

ENERGY OUTLOOK FOR CHINA: FOCUS ON OIL AND GAS

China has charted a bold course of economic reforms over the past 25 years, achieving mixed, but often remarkable results given the development challenges it faces. Reported average annual GDP growth of over nine percent has improved living standards for hundreds of millions of Chinese people to a level unmatched in any point of Chinese history. China now plays a key role in the supply and demand of many global commodity markets including steel, cement, and oil. (See Figure 1.)* If sustained, China's development will likely create the world's largest economy, as measured in purchasing power parity, in about two or three decades. Per capita wealth, however, will remain far below OECD levels. Enormous opportunities and

* Figures 1-4 have been retained in committee files.

challenges await commercial, governmental and social interests across the globe as China develops.

This document provides an update on current oil and natural gas trends in China, and looks at future growth projections. It is based largely on the International Energy Agency's dialogue and collaboration with China as a Non-Member Country participant. It begins with an overview of recent changes in the Chinese energy-economy relationship.

A CHANGING ENERGY-ECONOMIC RELATIONSHIP

Chinese energy demand has surged since the arrival of the new millennium, when a new round of investment-driven economic growth began. Preliminary Chinese data indicate that the energy elasticity of demand (the growth rate of energy consumption divided by that of GDP) surpassed 1.5 in 2004. In other words, for every one percent increase in GDP, energy demand grew by over 1.5 percent. The shift reverses China's recent historical trend of maintaining energy elasticity below 1.0. (See Figure 2.) For most developing countries, including India, Brazil, and Indonesia, energy elasticities greater than 1.0 are normal, but for China it is a groundbreaking change.

Many analysts rightly question the validity of Chinese economic and energy statistics; GDP is likely underreported right now, although from the late 1970s until the end of the 1990s, it was probably overstated. Likewise, Chinese energy consumption, coal in particular, is tracked poorly. Coal use from 1996-1999 is now regarded as massively underestimated by analysts both inside and outside of China due to untracked output from small coal mines. One of the contributing factors behind China's current energy crunch is indeed these poorly tracked energy statistics: good energy policy and energy planning require accurate data.

Despite the problems with data quality, the general trend raises concern. Is this new energy-economy relationship in China temporary or does it indicate a deeper structural change within the economy? The difference could have a profound impact on future global energy markets, energy security, and environmental quality. Almost no authoritative research has been published to explain the surging elasticity. A clearer understanding of what is happening in Chinese energy markets may never be uncovered, but more research into the new energy-economic relationship would benefit the international community and China.

OIL SECTOR: THE SEARCH FOR SECURITY

China surpassed Japan in late 2003 to become the world's second largest petroleum consumer. In 2004, Chinese demand grew 15 percent annually to 6.37 million barrels per day (b/d), about one-third the level in the United States. Domestic crude output in China has grown only very slowly over the past five years. At the same time, oil demand has surged, fueled by rapid industrialization. (See Table 1.) Imports of crude oil grew alarmingly in 2003 and 2004 to meet demand, increasing nearly 75 percent from 1.38 million barrels per day (b/d) in 2002 to 2.42 million b/d in 2004. Imports now account for 40 percent of Chinese oil demand.

Table 1.—GLOBAL OIL DEMAND BY REGION

[in millions of barrels per day]

	Demand	Annual Change			Annual Change (%)		
	2004	2003	2004	2005	2003	2004	2005
North America ..	25.14	0.47	0.57	0.23	1.9	2.3	0.9
Europe	16.47	0.20	0.26	0.10	1.2	1.6	0.6
<i>China</i>	6.37	0.55	0.85	0.36	11.0	15.4	5.7
Other Asia	8.54	0.22	0.44	0.21	2.8	5.4	2.5
FSU	3.69	0.12	0.11	0.14	3.5	3.1	3.9
Middle East	5.88	0.20	0.32	0.26	3.7	5.7	4.5
Africa	2.81	0.04	0.07	0.09	1.7	2.4	3.3
Latin America ...	4.89	-0.09	0.16	0.10	-1.9	3.5	2.1
World	82.45	1.85	2.66	1.44	2.4	3.3	1.7

Source: Oil Market Report, December 2004, IEA.

As described in the IEA's December 2004 *Oil Market Report*, a significant driver of recent oil demand growth in China—perhaps on the order of 250-300 thousand

barrels per day—has been the need for oil-fired back-up power generation in the face of serious electricity shortages. Other contributing factors are the rise in personal car ownership and growing industrial petrochemical needs, which are likely to continue growing fairly steadily. However, the amount of fuel oil and diesel used for back-up power generation will likely decline, as China closes the generation shortage by installing new coal, natural gas, hydro, and nuclear power plants. It has also promised to institute tougher new demand-side efficiency measures.

Chinese policymakers and state-owned oil companies have embarked on a multi-pronged approach to improve oil security by diversifying suppliers, building strategic oil reserves, purchasing equity oil stakes abroad, and enacting new policies to lower demand.

Diversifying Global Oil Purchases

Over the past decade, Chinese crude imports have come from a much wider and more diverse set of suppliers. In 1993, almost all of China's crude imports came from Indonesia, Oman, and Yemen. By 2004, Saudi Arabia was China's largest supplier accounting for 14 percent of imports, with Oman, Angola, Iran, Russia, Vietnam, and Yemen together supplying another 60 percent, and the remainder which came from a long list of other suppliers.

Establishing Strategic Oil Reserves

China's 10th Five-Year Plan (2001-2005) called for the construction and use of strategic petroleum reserves by 2005. Construction has begun at one of four sites slated to store government-owned supplies. Chinese officials plan to gradually fill up to 100 million barrels of storage by 2008 (equivalent to 35 days of imports then). Original plans called for boosting stocks to 50 days imports in 2010, but this may be slightly delayed. On the other hand, the recent surge in imports has led Chinese policymakers to consider an even more aggressive long-term plan for 90 days of stocks, perhaps by 2020.

The IEA has shared experiences with China on member country stockpiling practices since 2001. Chinese officials have stated their intent to slowly fill their new stocks depending on global conditions. They have demonstrated less concern, however, in coordinating release of their future stocks as part of a larger global system. In other words, China may be more inclined to use strategic stocks to influence prices even without the threat of severe supply disruptions. We are exploring this.

Overseas Equity Oil

Chinese state-owned oil companies have accelerated their hunt for overseas oil assets as part of the country's larger "going out" strategy. Growing foreign exchange holdings fuel the general outward drive of Chinese companies. While a significant number of oil-related announcements have been made in the press since 2001, much of this activity is still waiting to be finalized. The lack of transparency over investment amounts, production sharing contract details, and proven petroleum reserves may create a more successful image of Chinese companies than is actually the case.

Until recently, Chinese companies seemed most comfortable operating in locations not dominated by the oil majors. This meant countries like Sudan, Angola, and Iran. For example, over half of Chinese overseas oil production currently comes from Sudan. Activity has picked up in other areas recently, however, including Russia, Kazakhstan, Ecuador, Australia, Indonesia, and Saudi Arabia to name just a few. Chinese companies appear to be improving their ability to purchase assets without overpaying, as earlier reports suggested, but this conclusion is only supported with anecdotal information.

In 2003, Chinese state-owned oil companies pumped 0.22 million b/d of equity oil. The figure is projected to rise by 8 percent annually thru 2020 when it hits 1.4 million b/d. Leading the drive among Chinese state-owned companies, China National Petroleum and Gas Company (CNPC) claims to have petroleum assets in 30 countries. It plans to spend \$18 billion in overseas oil and gas development between now and 2020. Most of CNPC's overseas production currently comes from Sudan, Kazakhstan, and Indonesia. Many speculated that CNPC would take a share in the restructured assets of Yukos; rumors in late January 2005 foresaw a \$6 billion "loan" to Rosneft for long-term oil purchases, but no equity investment.

A disappointment for China during the year included the Russian decision to build an oil pipeline to Nakhodka with Japanese contributions, rather than to Daqing in northeast China with CNPC's participation. Discussions are still ongoing regarding a potential spur line that would feed China's northeast. In contrast, China and Kazakhstan made rapid progress in negotiating and starting construction on a cross-border pipeline that will initially deliver 0.2 million b/d of crude and products to Xinjiang province, and possibly later doubling to 0.4 million b/d. China

appears to have made a geopolitical decision to secure its oil supplies with this line as costs would probably not pass a commercial test.

China Petroleum Company (SINOPEC) is newer to the international game than CNPC and hopes to start pumping smaller quantities of equity oil in 2005 from activities in Yemen, Iran, and Azerbaijan. Perhaps the largest story in 2004 was SINOPEC's agreement in Iran to spend \$70 billion over 25 years to purchase LNG cargoes and participate in upstream oil activities there. Many uncertainties remain, however, before the investment is sealed.

China National Overseas Oil Company (CNOOC), the most progressive and outwardly-oriented of the Chinese state-owned oil companies, has been very active in Australia and Indonesia. In 2004, it succeeded in securing significant natural gas stakes in both countries. CNOOC surprised the global community in early 2005 when it was rumored to want to purchase Unocal for roughly \$13 billion. Little additional information has appeared in the press since then. These types of announcements tend to create an image of Chinese companies wearing bigger shoes than they actually do.

In summary, Chinese companies are increasingly active abroad and appear to be improving their business skills. They have not yet demonstrated that they can improve long-term oil security in a cost effective manner, however, as other Asian state-owned oil companies have learned.

Demand-Side Measures

Per capita oil consumption in China is only one-fourteen the level in the United States, indicating that strong growth could continue for many years. The transport sector in China will likely experience the strongest demand for oil over the mid- to long-term. Currently, there are roughly 24 million vehicles in China, with projections anticipating 90-140 million by 2020. This would push transport demand from 33 percent of total Chinese petroleum demand to about 57 percent (from 1.6 million b/d in 2004 to roughly 5.0 million b/d in 2020).

To partially address this problem, China enacted new automobile efficiency standards in late 2004. In Phase I, running from mid-2005 until January 2008, no increase in fleet fuel consumption will be allowed without penalties. Phase II would then begin and require a 10 percent reduction in fleet fuel consumption.

Another measure that has gained renewed attention is the imposition of a vehicle fuel tax. This policy would ban all road use fees instituted at the local level and replace them with a nationwide tax ranging from 30-100 percent of the current price of vehicle fuel. Gasoline prices in most Chinese cities, for example, are currently the equivalent of about \$1.60 per gallon. The fuel tax, if enacted, would raise gasoline prices to \$2-\$3 per gallon. The initiative has been discussed for years but lacked uniform support from policymakers. It has gained new steam over the past year with the surge in imported crude volumes.

THE LONG-TERM VIEW

Without measures to limit demand or create alternative fuels, Chinese oil consumption appears set to grow rapidly for the foreseeable future. The *World Energy Outlook 2004* forecasts Chinese petroleum demand in 2030 at just under 14 million bpd, about one-third less than current demand in the United States. (See Figure 3.) China's import dependency will continue to grow, however, reaching 75 percent. In 2030, China would be importing as much oil as the United States did in 2004. China itself forecasts a lower figure in the future, but we will wait until the necessary policies are in place and in effect before we adjust our number down.

The IEA believes there are enough worldwide petroleum reserves to meet global demand through 2030 and beyond. More important uncertainty relates to marshaling the necessary upstream investments, maintaining stable petroleum output in major producer countries, mid and downstream infrastructure among consumers, and dealing with environmental issues like climate change.

THE PROMISE OF NATURAL GAS IN CHINA: WHITHER POLICY?

China has taken major steps since 1997 to boost natural gas use, mainly as a way to improve urban air quality. But gas was largely ignored for most of China's modern history and new market-oriented measures are needed to fully encourage natural gas use.

Domestic gas production currently stands at 40 billion cubic meters (BCM) and accounts for roughly 3 percent of the country's total energy demand. Chinese policymakers envision gas use rising substantially through 2020, when demand would reach 200 BCM and account for 10 percent of total energy demand. Baseline IEA

estimates are currently less optimistic of future gas markets in China,¹ but the potential for dramatic change in China cannot be discounted. With the right policy framework, gas use could be significantly higher than even Chinese government forecasts.

Chinese policymakers increasingly view natural gas as the fuel of choice for its environmental, security, and industrial advantages. But the gas industry is in its infancy and many barriers must be overcome before this relatively clean energy source can make a significant impact. The International Energy Agency recently completed a detailed study of China's gas sector and delivered important recommendations to the Chinese government.² Provided below is a summary of why China is promoting development of the gas sector, the challenges it faces, and how some of these barriers could be addressed.

Drivers for Natural Gas

China is taking new measures to promote the use of natural gas for three reasons. First, natural gas used in place of coal can help China address environmental problems that have become urgent economic and social issues. Replacing coal with natural gas basically eliminates emissions of sulphur oxides and particulates, the two most serious local and regional pollutants. Gas also offers steep reductions in nitrogen oxide and greenhouse gas emissions.

Second, natural gas can help China diversify its energy resources and address growing concerns over energy security. Imported crude oil now accounts for 40 percent of annual demand and will likely continue to grow rapidly. Additionally, coal demand has soared since 2002, resulting in localized transportation bottlenecks. China could help alleviate these energy security concerns by increasing reliance on natural gas.

Finally, natural gas has the potential to accelerate modernization of the country's industrial facilities. Most of China's industry is based on coal-burning technology, which is inherently less efficient than gas-fired equipment. Modern natural gas boilers, for example, convert about 92 percent of the energy contained in natural gas to useable heat. Coal boilers on the other hand, waste 20 percent or more of the input energy in the process. Similarly, advanced combined-cycle gas turbines used to generate electricity are nearly 60 percent efficient, while coal-fired steam turbines convert only about 40 percent of the energy in coal into useful electricity.

Developments and Hurdles

Important gas projects have been launched to support China's ambitious development targets for natural gas. A 3,900 kilometre, \$24 billion West-East Pipeline started commercial operation in late 2004. (See Figure 4.) Throughput will slowly ramp up to 12 BCM in 2007 as downstream projects and distribution networks are completed. The fact that CNPC completed the pipeline one year ahead of schedule, and without participation from its planned investment partners (Shell, Exxon-Mobil, and Gazprom), is testament to the drive and ability of Chinese energy companies. Although many outside observers question the economics of the pipeline, similar doubts were raised when China built its first gas pipeline to Beijing. The economics were shaky at the time, but that line is now oversubscribed and a second line will begin delivering gas to the capital in 2006.

Two LNG terminals are also under construction in southeastern China, with perhaps a dozen more under discussion and consideration. LNG imports in China became an extremely hot topic in 2004 as coal prices rose substantially, along with incomes and air pollution. If even half of the LNG terminals currently under discussion are built, China could be importing 30-35 BCM of natural gas by 2015.

Talks continue on international natural gas pipelines with Russia and Kazakhstan as well, but progress has been slow. A joint feasibility study funded by Russia, China, and South Korea that would deliver 20 BCM of Russian gas to China and 10 BCM to South Korea is currently under evaluation. This pipeline may also have been ahead of its time, but Russia's Gazprom blocked any further discussion of the deal.

Important hurdles exist for natural gas market development, including:

- Natural gas is expensive compared to coal if environmental costs are not included;

¹The *World Energy Outlook 2004* forecasts natural gas accounting for 6 percent of China's total final energy consumption in 2030.

²Interested readers should consult this IEA publication for more complete information: "Developing China's Natural Gas Market: Policy Framework and Investment Conditions," International Energy Agency, Paris 2002.

- China is not believed to be endowed with abundant and cheap gas reserves, and known supplies are often located far from the main centers of demand;
- Gas supply infrastructure is fragmented and huge investment is needed to finance its expansion;
- China lacks a legal and policy framework to encourage investment in the gas sector; and
- There is a lack of knowledge over how to best develop natural gas technology and markets.

Perhaps the weakest link in China's current natural gas chain is the perception of high costs that results in weak demand for gas. Without stronger market pull for gas, the entire natural gas chain will remain weak, no matter how much the government tries to development the market by administrative dictate.

Recommendations from the IEA Study

General recommendations from the IEA study to improve the situation in China include:

1. Publishing a "White Paper" on natural gas policy as part of a coherent national energy policy framework;
2. Establishing a legal basis for natural gas;
3. Making environmental protection a component of energy pricing; and
4. Creating a central administration for energy.

Policy Framework for Natural Gas

To realize the ambitious target for gas market development in China, there is a need for the government to go beyond the "project-by-project" approach by publishing a comprehensive national natural gas policy. Such a policy could address issues of gas exploration, development, distribution, pricing, marketing as well as imports. It should be part of a coherent national energy policy, as China's gas industry is intertwined with the coal and the electrical power industry, and with environmental policy.

Through the elaboration of the "White Paper", the government can make a clear and formal statement of its policy objectives and long-term strategy for natural gas in China. The process of elaboration and consultation is critically important: the government should consult as many actors as possible within and outside the central administration.

Legal Framework for Natural Gas

Preparation of a national natural gas law is an urgent priority. Such a framework would provide a clear legal expression of the government's policy and strategy for gas industry development and the ground rules for operation of the gas industry.

Almost every country where a natural gas industry has been established, whether based on indigenous resources or imports, has adopted a gas law in the early stages of market development. Adopting such a law would help create a more stable environment for investment and operation, reduce uncertainty and investment risk, and consequently lower the cost of capital.

It should codify the roles, rights and responsibilities of different players as well as regulatory principles in the industry to reduce conflicts of interest and to ensure a level playing field for all. It should provide the legal basis for short-term gas market development activities, such as gas contract negotiations and enforcement. It should also be flexible enough to cope with market evolution over the medium and long-term.

Price Energy to Account for the Economic and Environmental Costs

Theoretically, environmental protection, in particular the reduction of local atmospheric pollution, is the key driving force for increased gas use in China. However, important challenges remain in turning this theoretical driver into a real market mover. China has put in place a whole set of environmental laws and regulations on air pollution, but a lack of adequate means for enforcing implementation makes most of them ineffective.

In power generation and industrial boilers, in addition to strengthening the enforcement of existing regulations, the use of economic instruments must be extended. To start with, the price penalty per ton of emissions (SO₂, NO_x, particulates) should fully reflect the market value of emission permits and take into consideration the health damage to the public. Many OECD countries include the price of environmental externalities in power generation, at least in planning exercises to determine the best choices for future power plant additions.

A Central Administration for Energy

At the time of the IEA study, China lacked a central body to address the country's overall energy strategy. Since the abolition of the Ministry of Energy in 1992, China did not have a single central-government entity in charge of energy policy and regulatory matters. Energy sector responsibilities were spread across several ministries. As the government is strongly committed to removing the policy-making and regulatory functions from state-owned companies, it needs to strengthen its own resources for governing them.

This recommendation by the IEA was recently implemented by the Chinese, although the newly formed Energy Bureau within the National Development and Reform Commission does not have enough staff or resources to perform all the necessary functions. There are roughly 30 employees at the Energy Bureau in China, while most OECD countries would have hundreds, if not thousands, of employees to create the policy framework and oversight needed to steer a modern energy industry. Given the current shortages of electricity and coal, Chinese planners are again considering restructuring of the central energy planning body.

SYNOPSIS

China's rapid economic growth is creating dislocations both at home and, increasingly, around the globe. These changes create both challenges and opportunities. China's rapid growth over the past few years should also be kept in perspective: China's 1.3 billion people currently consume only one-half the energy as the 290 million citizens in the United States, and Chinese oil demand is only one-third as large. While Chinese policymakers have done a laudable job of steering economic reform, a huge number of challenges—from population imbalances and environmental pollution to corruption and AIDS—await solutions before the country can raise individual standards of living to anywhere near current OECD levels. The international community must engage China in order to minimize the challenges and maximize the opportunities that lie ahead.

The CHAIRMAN. Thank you very much. I want to just clarify one. It seems to me that you were saying the future for them is natural gas in China, and we should be interested in pursuing with them how that might happen. What kind gas and where would they get it? Are you speaking of LNG or just straight natural gas?

Mr. LOGAN. I am speaking about both the domestic natural gas that is available in China and pipeline gas from Russia, from Kazakhstan, and LNG imported from a host of potential countries.

The CHAIRMAN. Thank you.

I note that Senator Thomas from Wyoming is here. Senator, there were brief remarks by each Senator. Would you like to make some? Oh, Senator Bunning, you are first.

Senator BUNNING. I will put mine in the record.

Senator CRAIG. Thank you very much, Senator.

[The prepared statement of Senator Bunning follows:]

PREPARED STATEMENT OF HON. JIM BUNNING, U.S. SENATOR FROM KENTUCKY

Mr. Chairman, I am pleased we are having this hearing today.

Understanding our energy needs is important so that our country can plan for its future.

As we have seen in recent years, energy prices can have a tremendous impact on our economy. Many businesses and consumers are begging for some relief from the current high energy prices.

I hope that we are able to pass an energy bill this year that will provide an energy policy that we have need for some time now.

Coming from a coal state, I want to work to make sure that coal continues to be a vital energy source. It produces fifty percent of our electricity today and should play a large role as a cheap energy source for our future.

I hope that we can continue to work to bring new clean coal technology quickly into the commercial sector.

I thank the witnesses for appearing before us today. I look forward to hearing their testimony.

Thank you, Mr. Chairman.

Senator THOMAS. I will not comment right now, sir.

The CHAIRMAN. Thank you very much.

Please proceed. Tell us what you do please.

**STATEMENT OF ANDREW J. SLAUGHTER, SENIOR ECONOMIST,
SHELL OIL COMPANY**

Mr. SLAUGHTER. Good morning, Mr. Chairman and members of the committee. My name is Andrew Slaughter. I am a senior economist with the Shell Oil Company here in the United States, and I would like to thank you for the opportunity to come to this morning's hearing. I am here to give you some insights about Shell's most recent global scenarios. They are in my written statement, and I will summarize the main points to you this morning. I am going to focus on the global scenarios, not so much on specific policy recommendations for the short term.

We have used global scenarios for over 30 years in Shell, and they are a means for us to explore the future for the world and for the industry. They are not predictions. They are really frameworks for thinking, used to challenge our conventional wisdom, and characterize plausible alternative future paths for the world. I think they are of interest to you, as you look at the future of U.S. energy markets, and we find them useful when we are looking at options to deal with really the two major challenges for the global industry in the 21st century.

Mr. Caruso and Mr. Logan have referred to the pace of energy demand growth globally and the United States, how do we meet that, once both growing very fast and shifting in nature, but also how will be responsive to the impact of energy use on natural systems not only here in the United States, but around the world. I think we have to consider those two points.

If I can set the stage for where we started with these scenarios. In the 1990's, the world was characterized by the forces of market liberalization, globalization, and technological progress both in energy and in many other sectors. As expected, the role of governments around the world shrunk in that environment. They had a smaller role to play. However, today since 2 years ago, the role of governments is increasing in response to the two crises we have faced: the security crisis following 9/11 and the market trust crisis following Enron and other corporate scandals. So governments have a greater role to play both in energy markets and in the general policy than we might have anticipated a couple of years ago. And that creates tensions between society's aspirations for security, market efficiency, and social cohesiveness.

Each of the three new global scenarios we have developed at Shell explores the tradeoffs between these three aspirations, only two of which can really be satisfied at any one time. The scenarios are called: Open Doors, Low Trust Globalization, and Flags. I am going to outline the main points from each of these three scenarios and suggest some energy market implications we need to think about when we are facing the challenges that I referred to.

In Open Doors, the first scenario, the drive for market efficiency and society's desire for social cohesion are satisfied, giving security more of a back seat. Governments choose to operate via incentives. Markets are open. Trade barriers globally are lowered, leading to

strong economic growth in energy demand above historical trend rates. In Open Doors, energy markets evolve following free market principles and respond to consumer preference for cleaner fuels and equitable resolution of environmental externalities using the pricing mechanism.

U.S. energy policy in this scenario would be driven by market efficiency. The United States would become more open to international gas trade, allowing market-based development of import infrastructure. Enhanced access to domestic gas would be acceptable if economic and balanced with environmental objectives. In this scenario, LNG imports would grow the most rapidly because of the connections to international markets.

Renewable energies and unconventional fuels would be developed subject to the discipline of the market and not duly inhibited by regulation. Environmental costs will be internalized in energy pricing via market mechanisms like CO₂ permit trading. And technological progress would drive the penetration of new energies such as hydrogen fuel cells.

This would be an efficient world in terms of development of energy supplies, but it is not without risk. If the United States or major consuming markets like Europe follow an Open Doors philosophy and other major actors in the energy world do not, that is a risk. Most of the new oil and gas production is coming from non-OECD countries. Fossil fuel extraction is increasingly dominated by State-run national oil companies who have sometimes completely different drivers from the international oil companies in the western hemisphere. So that poses a potential risk to international energy security.

In the second scenario, Low Trust Globalization, we still have a drive for market efficiency, but governments play a stronger role in terms of security and influencing choices. Government regulation and oversight guarantee public safety and investment security. But there are institutional barriers from that position which slow innovation, resulting in lower economic growth and energy demand growth. So energy markets have to respond to the security imperative in a greater way in this scenario.

The U.S. policy here would use market incentives and increased regulation for long-term energy security. The need to proceed with caution with regard to public security and environmental protection could delay or reduce the scope of development of import infrastructure and the access to domestic gas resources. The United States would need to look to its neighbors for help in developing unconventional resources on a continental basis, and that might be an attractive solution. You could also envisage renewable and unconventional energy resources being subject to more favorable, proactive government policy like tax credits, investment subsidies, or R&D support, but it is still unlikely that the pace of take-up will be sufficient to offset lower availability of gas supply. You might, therefore, have to consider demand-side initiatives, for example, efficiency standards or energy taxation, to bring down overall price levels.

In the third scenario, Flags, the role of government is even stronger, focusing on social cohesion and security. Regulation is more fragmented, tailored purely to national concerns. Bilateral

trading arrangements are the norm. You still have tensions in international relations. These lower economic growth to below historical trends, with energy demand correspondingly slower. Domestic energy sources will be promoted, and competition for access to resources in markets could favor energy companies which are state controlled will have strong support from their host governments. There would be a greater focus on indigenous supply and demand of energy in this scenario, even at the expense, potentially, of cost competitiveness or environmental standards. The increasing challenges of balancing supply and demand could risk driving up U.S. energy prices and lead to stronger pressure to open up more domestic resource areas, such as moratoria areas or Federal lands, and again move to alternatives, such as unconventional, biofuels, and nuclear. And there might have to be more stringent demand-side measures.

Over all the scenarios, I think there are four big risks and constraints our industry will follow now and into the future: resource depletion and access to new resources, rapid energy demand growth, increasing State control of resource development, and climate change. We cannot predict which direction the world will develop over the next 20 years. Therefore, we think U.S. energy policy should be prepared to envisage multiple possible outcomes, build bridges to international markets, develop pragmatic domestic energy policies over the full range of supply and demand in partnership between legislators, regulators, private companies, and other stakeholders.

Very long lead times are necessary to shift the structure of energy supply and consumption in a mature energy market. There are sufficient warning signs now that we need to take precautionary policies for the future of energy security for our children and grandchildren.

Thank you, Mr. Chairman, members of the committee. That concludes my statement.

[The prepared statement of Mr. Slaughter follows:]

PREPARED STATEMENT OF ANDREW J. SLAUGHTER, SENIOR ECONOMIST,
SHELL OIL COMPANY

Andrew Slaughter represents Shell as a member of the global scenario and strategy team and as Shell's specialist on North American energy markets. The views expressed here are intended as contributions to a discussion on possible long-term energy security alternatives for the U.S., from the perspective of Shell's current scenario thinking. This submission is focused on the frameworks provided by Shell scenarios and does not discuss specific policy proposals that Shell might support or that Congress might consider.

SUMMARY

Shell's Global Scenarios are developed to provide a challenging framework for thinking about longer-term political, societal and economic trends and their potential impact on the global energy system. The main purpose of this is to test our business strategies and robustness of business plans. For over 30 years, successive Shell scenarios have been the source of powerful insights for the Shell Group. We hope these frameworks provide multiple perspectives on the choices available to develop U.S. energy security.

The world's energy system will face two key challenges in the 21 century:

- meeting expanding and shifting energy needs with secure supplies, and
- responding to the impact of our energy use on the natural systems on which we all depend.

Energy security is increasingly becoming a factor of concern to major energy-consuming countries, such as the U.S., under the pressures of accelerating demand growth, anticipated constraints on future supply growth, and environmental objectives. This global issue can only be resolved over the long-term, taking full account of international interdependencies, the rising needs of developing economies, and trust and cooperation between private and public sectors.

The scenarios explore a number of different paths to energy security—depending in which direction our world will develop—whether through opening markets and facilitating international free energy trade, establishing diversity of supply in conjunction with pragmatic demand and market policies, or the continuation of the old ways of bi-lateral political agreements securing point to point long term supply lines and markets.

Perhaps the most underestimated threat to domestic energy security would be an assumption by policy makers that all countries are heading towards the same scenario and at a similar pace, and design policies on that basis, even though reality may be more complex.

A focus on supply and demand measures is critical. In the U.S., the supply side is heavily impacted by policies that allow or deny access to new resources. A scenario that allows greater access to resources will benefit supply, especially for natural gas. But energy systems can only evolve slowly, due to the longevity of capital stock; energy security of 2015 and beyond requires planning and policy today.

Demand measures can have a much faster impact than changes on the supply side and need not result in adverse impacts on the economy, consumer welfare or lifestyles.

INTRODUCTION

For over thirty years Shell has regularly prepared scenarios exploring potential future developments of our society, our business environment and the energy industry in which we work. These scenarios are not forecasts, preferences or the description of deterministic cause and effect patterns; rather, they are frameworks in which to challenge conventional wisdom, identify plausible alternative futures for our societal and business environment and bring critical uncertainties into the open, such that our business leaders can think through appropriate strategies and responses. Shell uses these scenarios both to think about the future and to test, in a very practical way, current strategies, plans and projects.

We develop Global Scenarios that focus on societal, political, economical and institutional trends and key uncertainties, Long-Term Energy Scenarios that look at energy resources, supply and demand, and specific regional or sectoral scenarios to meet particular business needs.

Over the past 30 years or so, scenario thinking has enabled the Shell Group to identify in advance some of the major turning points in our industry—the oil price shocks of the 1970s, the periods of low oil prices in the mid 1980s and late 1990s, the emergence of global concerns regarding sustainable development, and the radical acceleration of market liberalization, globalization and technological progress through most of the 1990s.

We have recently completed a new round of Global Scenarios. I would like to review the principal themes and draw out some of the main implications for global and U.S. energy markets. Over the next twenty years or so development of energy markets may be facing increasing pressures. We need to prepare for a world in which continuing growing energy demand from rapidly developing countries, such as India, China and Brazil, as well as continued demand growth in North America creates more competition for traditional energy sources and might require faster penetration of new energy sources. A second challenge involves the sustainability of traditional energy, particularly oil and gas, in the face of the accelerating pace of demand growth. We can characterize these challenges in terms of energy security—not energy security as a function of short-term supply disruptions, changing stock levels or our ability to cope with extreme weather, but energy security in terms of sustaining a growing demand for energy over the long-term in a system where shifts in the market are incremental at best and lead times to build new alternatives can be very long.

Scenarios are a useful framework for thinking about these issues, both informing us about potential directions of change and helping to initiate the debate today about actions we need to set in motion to secure a long-term sustainable energy future for our children, our grandchildren and ourselves.

Today's testimony will focus solely on Global Scenarios and will not include any specific policy recommendations. Last month, Shell shared specific policy rec-

ommendations with the Committee in response to Senator Domenici's request for public input on the natural gas supply and demand situation.

THE NEW SHELL GLOBAL SCENARIOS

The new Shell Global Scenarios build on the worldviews developed in previous scenario rounds, in particular the onward march of market liberalization, globalization and technological progress (trends epitomized by former UK prime minister Margaret Thatcher's rallying call "There is No Alternative"). In the 1990s, these trends led to a diminishing role for the state as an actor in societal and market development. However, over the past four years, we have seen a resurgence in the activism and aspiration of states, with wide support from the public at large, as a response to the dual crises of security (9/11, Bali, Madrid) and weakening of trust in markets (Enron, WorldCom, Tyco). Our new scenarios describe a world in which there are constant tensions between the aspirations for economic efficiency, social cohesion and security. Since these three aspirations cannot all be completely satisfied concurrently, the world operates via trade-offs in which two of the aspirations become more dominant relative to the third. We have therefore described three possible worlds in which these tensions play out:

1. *Our first scenario, named Open Doors*, explores a world in which the drive for market efficiency is in balance with civil society's ongoing concerns to maintain or improve social cohesion, inclusiveness and access to equity. In this world the state prefers to operate via incentives. Pragmatic regulatory harmonization, strong independent media, voluntary best-practice codes and close links between investors and civil society support open markets, cooperation, high innovation and rapid economic development. Open markets combined with strong free trade growth facilitated by multilateral lowering of trade barriers allow world economic growth to follow a strong path, just above the historical average, and consequently requiring a high energy demand growth path. Energy markets in this scenario evolve following free market principles, responding to consumer preference for cleaner fuels and equitable resolution of environmental externalities via the pricing mechanism. International natural gas trade would expand most rapidly in this world allowing greater access to a cleaner fuel. Renewable energy and clean coal technologies also become more prominent in response to societal preference, but need to be competitive as well. Take-up is consequently slower than in the other scenarios.

2. *Our second scenario, named Low Trust Globalization*, is a world in which the aspiration for market efficiency remains strong but in which the state exerts a strong role in providing the public good of security, influencing choices, via regulation and other oversight instruments aiming to guarantee public and investor security. Institutional barriers and slower innovation would result in somewhat lower economic growth, slightly below the historical average, with world energy demand growing at about the same rate as has historically been the case. Energy markets in this scenario are more clearly focused on responding to policy objectives of achieving energy security, e.g. by proactively pursuing diversity of supply, being of the same commodity or alternative fuels, and by supporting interconnection of infrastructure networks, increasing regulation to accommodate cleaner fuels, like renewables, in the market and by demand policies.

3. *Our third scenario, named Flags*, describes a world in which the strong role of the state focuses more on social cohesion than on market efficiency. Here national preference is more prominent; regulation tends to be more fragmented and tailored purely to national concerns; trade is conducted on a bilateral basis; and latent tensions in international and inter-community relations are sustained. The more fragmented nature of international economic relations in this scenario leads to a low annual economic global growth rate, almost a percentage point below historical averages, and consequently a low rate of world energy demand growth. For energy markets, this would mean a reversion to national policies promoting domestic energy sources and securing imports by bilateral contracts; global environmental initiatives would lose impetus with the focus shifting back to local pollution issues, leading to fragmentation of approaches to mitigation; and competition for access to energy resources and markets could favor energy companies which are either state-controlled or which receive strong support from their home governments.

The dynamic tensions between these three worlds are present today and will continue for the foreseeable future. We can expect conflicting pointers indicating that we may be heading for one world or another. We need therefore to monitor the multiple developments in societies, markets, the legal system, regulation and international relations to determine whether we are moving in a particular direction. It is also possible that different regions of the world, including countries and regions of vital importance in supplying energy markets, operate in different scenario

worlds, inevitably leading to misunderstanding, confusion and the inability of actors to achieve their objectives. For example, if Europe acts in an Open Doors way, North America views the world through the lens of Low Trust globalization and the Middle East or Russia follows the path of Flags, and the parties do not recognize the different positions of the others, there will be little chance of any region achieving its objectives with regard to energy supply or access to markets in full. Energy security, in its broadest sense, will be at risk.

SCENARIO IMPLICATIONS FOR U.S. ENERGY SECURITY

Over the next 25 to 30 years, global energy demand could rise by over two thirds. Although much of the demand growth will come from developing countries such as China and India, most projections also see fairly significant energy demand growth here in the United States. For example, the recently released EIA Annual Energy Outlook 2005 projects total U.S. energy consumption to be over 35% higher in 2025 than it was in 2003. Oil, gas and coal are projected to remain the dominant fuels, growing by 39%, 40% and 34% respectively. The developing economies expect to see even faster energy consumption growth rates over a similar period as their economies expand. Our scenarios encompass these growth projections within a wider range of possibilities. Before going into that, let me first highlight some current trends and indicators:

- Increasing global oil and gas demand is resulting in faster depletion of existing resources. Although the overall global resource base is thought to be reasonably robust for the near future, issues of remoteness, increasing technical difficulty and therefore cost, and regulatory or fiscal uncertainties, may constrain development of these resources below the pace of demand growth.
- Global oil and gas exploration success rates are decreasing. The recent trend for oil and gas companies to return cash to shareholders via share buybacks rather than reinvest in core activities may be perceived to indicate a declining set of accessible resource development opportunities.
- The OPEC capacity squeeze in 2004 may have been a temporary phenomenon, but for the longer term several recent statements coming out of Saudi Arabia indicate a reluctance, or perhaps an inability, to expand its oil production capacity to much over 15 million barrels per day over the next two decades. Assumptions of old on the expandability of OPEC capacity to balance the oil market at almost any level of demand may therefore need reassessment.
- Natural gas production in the U.S. has essentially stagnated over the past three years despite consistently higher wellhead gas prices and correspondingly elevated drilling activity levels. Despite the cost to U.S. industry and consumers and the lost opportunity for oil and gas companies this situation has not yet led to action to improve access to potentially rich new resources, currently off limits.
- The pace of introduction of new sources of non-fossil fuel energy into the U.S. energy mix has remained slow and patchy, such that these alternative energies are not yet positioned to rapidly take up a more significant share of the market should the growth in the supply of fossil fuels to the U.S. fall below expectations, either through pressure on the resource base or through increased competition from fast-growing markets elsewhere.

The above factors are all signposts for potential vulnerability of global and U.S. energy markets in coming years. Responses and outcomes may be very different, according to the different ways the world evolves. Scenario thinking can help us in portraying these very diverse choices and outcomes. Each of the scenarios considers the full range of energy options in terms of fuel mix, policies and market solutions—with the differences being mainly a question of scale and timing.

The *Open Doors* world emphasizes resolution of these tensions through open markets and free trade, in energy as well as most other traded goods and services. In such a world an incentives based system with a minimum of state interference or conflicts, a stable regulatory framework and efficient competition and financial markets would deliver new production and infrastructure in a timely fashion. Such a system would need high trust, but would have the highest economic efficiency.

U.S. energy policy in this scenario would likely be driven by the desire to deliver sufficient energy at an affordable cost to the user consistent with consumer preferences for a clean and safe environment. The U.S. would become more open to international gas trade by allowing market-based development of import infrastructure while enhanced access to domestic gas resources would be acceptable in balance with environmental objectives. LNG imports grow most rapidly under this scenario, and more LNG would delay the need to develop some of the more remote, higher cost domestic gas resources. Renewable energies and unconventional fuels would be

subject to the discipline of the market, but would not be unduly inhibited by conflicting and onerous regulation, especially as true environmental costs could be internalized in energy pricing via market mechanisms, like CO₂ permit trading. Technological progress reducing the cost of new energy sources such as hydrogen fuel cells for distributed power would be the prime driver behind accelerating market penetration.

Such a world would lead to efficient development of energy supplies consistent with demand and consumer willingness to pay. However, pursuit of such an open markets policy in energy by the U.S. on its own bears the risk that other actors in international energy markets may not have the same assumptions nor follow similar models. With new oil and gas production coming increasingly from non-OECD countries, and where fossil fuel extraction is increasingly dominated by state run National Oil Companies with completely different drivers, this may be a real risk to energy security (see *Flags* below).

The *Low Trust Globalization* world achieves energy security by proactively seeking to diversify supply and ensuring sufficient interconnection between energy networks to ensure back-up and alternative supply routes. Supply diversity here includes both geographical diversity of supply source to avoid over dependency on regions with high geopolitical risk and diversity of fuel mix such that the total energy system is not overexposed to shocks related to one particular fuel. The state steps in to ensure these objectives are met, even if they are not the most efficient in purely economic terms.

U.S. energy policy in this scenario would likely encompass a mixture of market incentives and increased regulation to enhance long-term energy security. However, the perceived need to proceed with caution with regard to public security and environmental protection delays or reduces the scope of the development of import infrastructure, such as LNG terminals, and access to more domestic gas resources, either offshore or on federal lands onshore. The U.S. will certainly look at its immediate neighbors for help and the development of the unconventional resource base will look an attractive solution. While renewable and unconventional energy sources could be subject to more favorable and proactive government policies, through tax credits, investment subsidies or R&D support, it is unlikely that the scale of take up would be sufficiently strong or fast to compensate for lower availability of gas supply. Government policy will therefore have to shift somewhat towards demand-side initiatives, encompassing, for instance, efficiency standards or energy taxation, if overall price levels are to be contained.

The *Flags* world would involve a return to the “old order” in international energy markets, involving bi-lateral long term contracts, point to point connections and political horse trading to secure imports—in conjunction with strong government control on domestic demand and stimulation of indigenous supply—even if other objectives like cost competitiveness or environmental pollution are compromised. In such a world, it will be the national energy companies that will be favored in the producing as well as the consuming nations, and they have a different set of objectives and investment criteria, strongly driven—and backed-up—by their governments. Competition from these companies to access oil and gas resources may not result in delivery of greater volumes on to world markets but in capture of resources to meet domestic demand in their home countries. In this scenario, despite lower economic growth and consequent energy demand growth, the increasing challenge of balancing supply with demand in the U.S. would risk driving up domestic energy prices—and leads to strong pressures for the government to open up more domestic resources, bring access to moratoria areas and federal lands, or move to alternatives such as unconventional fuels, biofuels or nuclear. The portfolio of policy options in this scenario may also have to include stringent demand side measures. To the extent that the U.S. is forced to remain connected to international energy markets, a much closer link between energy policy and foreign policy would develop, in conjunction with policies for the energy industry structure.

No one can predict in which direction the world will develop over the next twenty years. As of today, some would argue that the world is somewhere between *Low Trust Globalization* and *Flags* with at times aspirations towards *Open Doors*, but directional signposts are often unclear or seem conflicting. We therefore believe it is sensible for U.S. energy policy to consider and be prepared for multiple possible outcomes—build bridges to international markets through infrastructure development and international cooperation, in conjunction with pragmatic domestic energy policies over the full range of supply and demand and with partnership and cooperation between legislators, regulators and private companies.

Scenarios explore trends, as well as “critical uncertainties”, by raising the “what-if” question. The Shell scenarios do not take a particular position with regard to the possibility of climate change caused by increased greenhouse gas emissions. However, one could consider the possibility that a real threat to energy security may not be the availability or access to hydrocarbon resources, high demand growth from the Far East, terrorist acts, regulatory uncertainty, or foreign policy, but climate change. The world’s CO₂ concentration is already more than a third higher than in all its history. We can therefore safely say that we are already in uncharted waters. What if the world accepts tomorrow that we can no longer afford to take a free rider on nature and must internalize the external costs by for example sequestering CO₂? This is possible, but will require a new infrastructure, which takes decades to build. But also wind, temperature and rain patterns may change, which could put the already built renewable infrastructure in the wrong place. Whether or not the Kyoto Treaty is an appropriate or successful response to these risks, the pace of change in our energy systems, particularly in mature markets such as the U.S. or Europe, is such that it is prudent to take preparatory steps earlier rather than later to prepare for a shift to a lower carbon-intensive energy future.

The CHAIRMAN. Thank you very much. I do not know if I want to really thank you for what you told us, but I guess we have to hear it.

[Laughter.]

The CHAIRMAN. We have had a new Senator arrive. Senator Alexander, everybody has been offered an opportunity to make some comments. Would you like to?

Senator ALEXANDER. Thank you, Mr. Chairman. I will listen. I have more of a question than a comment. Would you like me to do that later?

The CHAIRMAN. Yes, please. You will do it later when you get your turn.

Senator ALEXANDER. Thank you very much. The area that I would be interested in hearing more about is one we have discussed on both sides here, which is the extent to which coal gasification and carbon sequestration offers an option for us worldwide as we think about energy independence and environmental policy. I will listen for a while to that. When my turn comes, I will ask questions on that. I would be interested in what the private sector is doing and what they suggest we do to encourage that or if they even think that is a valid option.

Thank you.

The CHAIRMAN. Thank you very much.

Now, let us see. We have one last witness, Frank Verrastro.

STATEMENT OF FRANK A. VERRASTRO, DIRECTOR AND SENIOR FELLOW, ENERGY PROGRAM, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES

Mr. VERRASTRO. Mr. Chairman, members of the committee, I too appreciate the opportunity to appear before you today to discuss emerging global energy trends and their implication for U.S. energy security, energy needs, and policy choices.

The events of the past year have, once again, focused attention on the critical role which energy plays in our global economy. It is truly a strategic commodity, and consequently, I commend you and the committee for convening this hearing today.

You already have copies of my testimony, which I submitted, so I will take my time and summarize highlights and emerging trends, which we have developed at CSIS. I do this with the caveat

that identifying such trends is always easier in hindsight than in forecasting, but nonetheless, we go forward.

We have identified 10 trends worth noting. Beginning with the demand side of the ledger, one of the most striking trends—and Andrew and Guy have both referenced this—is the acceleration in the growth of global energy and oil demand, especially that exhibited in Asia, principally in China, but also in the United States. It took the world almost 18 years, from 1977 to 1995, to increase demand for oil from 60 million to 70 million barrels a day, yet less than 8 years to grow from 70 million to in excess of 80 million where it stands today. EIA projects that in 2010, only 5 years from now, global oil consumption will again increase to over 90 million barrels a day.

Current demand for the first quarter of this year is forecast to range between 83 and 84.5. Given the limitations on near-term OPEC and non-OPEC production capabilities, that range could well be the difference between a repeat of last year's price volatility and a more predictable rise. The primary question is, however, is that growth sustainable? Is it worthy of a designation as a trend or is it simply a short-term anomaly?

Demand growth for oil in Asia has, for the past few years, accounted for between 30 and 40 percent of all new global demand growth. Forecasts predict that global oil demand will continue to grow to between 120 million and 125 million barrels a day by 2025. That is 50 percent more than we currently consume. If true, the implications for world economies, infrastructure, and transport requirements, wealth transfers, the environment, and global geopolitics are indeed enormous.

In this context, I would also draw your attention to America's increasing reliance on imports of crude oil, refined products, and natural gas, and Guy referred to this earlier. To fill the gap between growing energy demand and declining production, EIA projects net oil imports to grow to almost 28 million barrels a day in 2025, with refined product imports accounting for a growing proportion of that demand. Absent the adoption of measures to increase domestic output, to improve efficiency, to ensure the construction of needed facilities and infrastructure, rationalize our fuel specification requirements, promote conservation, and pursue technological advancement, we run the risk of putting our transportation and power generation sectors, our economic well-being, and our national security at increased risk.

An added complication to last year's demand increase was that this growth surge came at a time when global inventories were low by historic standards and spare productive capacity, both in terms of crude quantity and quality, especially for lighter, sweet crudes, were both in support supply. In addition, the absence of spare capacity or properly configured U.S. and global refining capability made converting those available crudes into needed products more difficult, if not impossible. Global spare capacity at about 1.5 million barrels a day is at its lowest level in 30 years, declined from an average of about 2.5 million barrels a day in the 1990's and from over 5 million barrels a day only 2½ years ago.

The confluence of these conditions, coupled with the concerns over increased global instability and supply disruptions in dis-

parate parts of the world, ranging from strikes in Nigeria and Norway to concern over output from Venezuela and Russia, from the loss of U.S. gulf supplies as a result of Hurricane Ivan, and sabotage in Iraq, and for at least a portion of the summer when prices clearly exceeded levels that are attributable to market fundamentals, we saw an increased role of market speculators. Together, they combined to create a kind of perfect storm for oil prices in 2004.

As a consequence of these factors, assuming continued strong demand and limited supply, it is highly likely that we have moved to a higher price environment, especially for oil, substantially above the levels experienced over the last 20 years.

Against this backdrop, let me add three additional considerations that may well prove to be trend-worthy as we go forward, and those are the changing face of the global energy map, with distinct geographic separations between market givers and takers. We are also increasing concentration of supply clusters and demand centers which are not proximate to one another. As we go forward, the major supply centers look to be Russia and the Caspian, the Middle East, Africa, and unconventional supplies from Canada and Venezuela. When you pair that up against emerging demand centers, the United States, Europe, and Asia, mainly China, you can see that we have huge problems with transportation, security, and logistical support.

We also have the evolving role of the national oil companies—and Andrew has already highlighted that effect—and the substantial challenges faced by the international majors, both with regard to access to resource-rich areas, reserves replacement, and competition from nations rather than businesses. National oil companies currently control 72 percent of proven oil reserves worldwide, 55 percent of gas reserves, and over half of the oil and gas that is produced today.

Finally, the growing influence and power of non-state actors and the transformation of political governance, changes which have the potential for remaking global energy markets by refocusing nations' priorities around more centralized, ideologically justified policies, often at the expense of traditional free market forces and foreign investment. In this regard, the increased significance of oil and energy will invariably mean that those sectors are quite likely often to be in play politically.

Let me close with one final thought. Though it is too early to be identified as a trend, clearly a wild card issue as we go forward is global climate change and the follow-through activity with respect to Kyoto.

With that comment, let me thank you for your attention, and I too would be pleased to answer any questions.

[The prepared statement of Mr. Verrastro follows:]

PREPARED STATEMENT OF FRANK A. VERRASTRO, DIRECTOR AND SENIOR FELLOW,
ENERGY PROGRAM, CENTER FOR STRATEGIC AND INTERNATIONAL STUDIES,
WASHINGTON, DC

Mr. Chairman, Members of the Committee, I appreciate the opportunity to appear before you today to discuss emerging global energy trends and their implications for U.S. energy needs, security and policy choices. I currently serve as Energy Program Director and Senior Fellow at the Center for Strategic and International Studies

(CSIS). My remarks this morning are the result of analysis conducted at CSIS as well as from impressions and personal experience gleaned from my prior government service in a variety of energy policy positions and over twenty years experience in the private sector as an executive for domestic and international oil and gas companies.

OUR EVOLVING ENERGY WORLD

Mr. Chairman, the events of the past year have once again focused attention on the critical role which energy plays in our global economy. Rising global oil demand, concern over the adequacy, reliability, and pricing of energy supplies, the environmental implications of increased use of fossil fuels, the cost of those supplies for developed and developing economies alike, global geopolitics, trade and capital flows are issues that preoccupy business and governments around the globe. Consequently, I commend you and the committee for convening this hearing.

Given the critical importance of energy as a strategic commodity, a pivotal question is raised as to whether or not we should be managing its production, delivery and use differently as part of a larger effort to return to the consumer more acceptable control of his energy future. I would submit that as a consequence of having worked off the surpluses of spare global oil production and United States and worldwide refining capacity, witnessing the emergence of aggressive new players in the market, increased concentration of supply sources that are not co-located with future demand centers, and taking into account the environmental, security and foreign policy implications of these changes, a new global energy map may well be emerging and a new geopolitical game afoot.

U.S. consumers have come to both enjoy and expect a healthy domestic economy, which is underpinned by an energy supply that is at once available, affordable, secure, and environmentally benign. In this new world are those criteria unattainable or just beyond reach of current energy paradigms and policies?

While the focus of my remarks here today necessarily highlight the importance of oil and natural gas, it is important to note that coal continues to play a significant role for many countries, particularly with respect to power generation. In addition, continuing energy supply concerns and high prices will encourage increased coal production as a reliable, diverse, and cost competitive fuel source. Coal gasification, coal liquefaction, and clean coal technologies, all currently available, if applied on a sufficiently broad scale offer coal-rich countries such as the United States, India, and China an opportunity to minimize those concerns deriving from an increasing reliance on imported liquid fuels.

In addition, while not minimizing the contribution made by alternative energy forms, including nuclear and renewables, in the global picture for at least the next several decades these alternatives will remain cast in the roles of significant but clearly supporting actors.

I should also note that CSIS has not constructed a model of its own for forecasting future energy supply and demand. Consequently, my comments today draw heavily on forecasts and data from CSIS, 2/3/05,¹ a number of private sector and governmental sources, most notably those produced by the International Energy Agency (IEA) and the U.S. Energy Information Administration (EIA).

After analyzing the various factors that could affect global and regional supply and demand as well as policy issues that could alter the direction and timing of the various projections, it is our contention that sustained high prices, environmental challenges, foreign policy developments, and technological advancements invariably will produce an oil future different from that portrayed by either the EIA or IEA. We believe, for example, that the demand growth and production required to meet the forecasted demand of 120-126 million barrels of oil per day (mmb/d) in the next few decades are unrealistic, in part owing to the belief that production and delivery of 50 percent more oil than currently done today will strain existing resources, infrastructure, delivery systems, and the environment so as to be unsustainable.

PUTTING THE FUTURE IN CONTEXT—ENERGY CONSUMPTION TRENDS

The world of energy is changing and moving in directions that further complicate the tasks that lie ahead. If the world does not respond appropriately to these challenges, we risk confronting a future that is increasingly uncertain and defined by factors beyond our control or influence. At its present pace, the world population is

¹*International Energy Outlook 2004 (IEO 2004)*, Energy Information Administration, U.S. Department of Energy, Washington, DC, April 2004; *World Energy Outlook 2004 (WEO 2004)*, International Energy Agency/Organization for Economic Cooperation and Development, Paris, November 2004.

growing by almost 10,000 an hour almost a quarter million per day. These people will need food, housing and other products and services which invariably require energy to produce and deliver.²

For the next twenty years, most forecasts predict that the world will continue to rely on the same energy forms that fueled the past century—oil, natural gas, coal, nuclear and a broad grouping of renewables, including solar, hydro, biomass and wind energy forms. Indeed, although global energy demand is forecast to double between 2001 and 2025, little change is expected in the relative shares of the major fuel sources (Figure 1).*

In 2001, 85 percent of global fuel needs were met with fossil fuels, with oil (39 percent) being king, and renewables (8 percent) and nuclear (6 percent) playing supporting, but nonetheless important, roles. This global energy makeup, as expressed in percentage terms, was remarkably consistent even within disparate regions. Energy usage in North America, which currently comprises about 30 percent of world-wide consumption, essentially mirrored larger global trends.

Increased reliance on nuclear energy in Europe, in contrast, slightly altered the total energy mix by reducing demand for coal and natural gas. In the developing countries, those often least able to afford or employ best available technology, the use of fossil fuels exceeded 90 percent.

Given the long lead times necessary to develop and introduce new conventional supplies and alternative energy forms, absent an economic, foreign policy, or environmental crisis or a major technological breakthrough, demand for fossil fuels (oil, natural gas, and coal) is expected to continue to dominate the global energy mix for at least the next two decades.

In the case of the developing world, this trend is particularly dramatic. The IEA projection calls for developing Asia, including China and India, to continue its current economic expansion with GDP growth (5 percent annually over the forecast period), several percentage points greater than global growth as a whole.³ As a consequence, the energy demand accompanying such robust economic growth is expected to double over the next 2 decades (Figure 2), accounting for 40 percent of the total increase in projected world energy consumption over that period.

Although sustained high oil prices may ultimately moderate energy growth in Asia, the pace and level of the region's energy consumption could place serious strains on global oil markets and consequently raises significant concerns for both capital flows and emissions growth. Between now and 2025, over 60 percent of new growth in CO₂ emissions is projected to result from energy use in the developing world (Figure 3). The problem only gets worse with hyperurbanization. By 2025, CO₂ emissions from the developing world will exceed those of the industrialized world, and by 2015 will achieve parity with the developed nations.

Of the total energy consumed worldwide, approximately 40 percent serves power generation needs and another 20 percent goes to transportation. Half the world's oil half of an 82 million barrel-a-day market is dedicated to transportation. In the absence of a substitute liquid fuel or changes to the gasoline combustion engine, this demand is becoming increasingly inelastic, especially in the United States, the world's largest oil consumer. Without improved efficiency and fuel capability changes made to the power and transportation sectors, energy demand cannot materially be reduced.

THE ROLE OF THE UNITED STATES

The United States is currently the world's largest producer, consumer, and importer of energy. The United States has roughly 5 percent of the world's population and produces 17 percent of the total energy supplied. Yet in the process of generating almost a third of global GDP, the United States consumes nearly a quarter of the world's energy.

The 2004 EIA forecast projects that overall energy usage in the United States will continue to increase at an annual growth rate of 1.5 percent for the next 20 years. Total U.S. demand for oil is projected to increase by 40 percent from current levels (slightly in excess of 20 mmb/d) to almost 28 mmb/d in 2025. Demand for all forms of petroleum fuels except for the bottom of the barrel increase, but total gasoline demand increases dramatically after growing slowly for the past 15 years, largely as a result of fuel efficiency standards adopted in the 1970s.

²"*The Outlook for the World Oil Market.*" Lord John Browne, Group Chief Executive, BP, Speech given at the Empire Club of Canada, Toronto, December 10, 2004.

* Figures 1-8 have been retained in committee files.

³See IEA forecast for developing Asia, "Chapter 8—Regional Outlooks," *WEO 2004*, IEA.

Assuming a continued decline in domestic crude oil production, and with U.S. refineries running at or near capacity, absent substantial new investment, increased domestic demand means expanding reliance on imported oil, both crude and, increasingly, refined products. U.S. oil import reliance is expected to grow from the current level of 58 percent to between 65 and 75 percent of demand by 2025, depending on assumptions about price and economic growth.

The rise in oil import levels, both in absolute and relative terms, carries important infrastructure, logistical, environmental, financial, trade, security, and foreign policy implications. In particular, Carbon Dioxide Emissions 1990-2025 the projected rise in refined petroleum product imports increases U.S. vulnerability to supply disruptions and potentially undermines the value of the Strategic Petroleum Reserve (SPR), assuming investment continues to lag in the creation of additional refining capacity.

A similar picture emerges for domestic natural gas. After an era in which gas was undervalued and in surplus supply, domestic production has plateaued and now begun to decline. As demand continues to grow and the EIA projects increased use of gas domestically primarily for power generation the United States will rely increasingly on nonconventional domestic production (e.g., tight sands and coal seam gas), gas from Alaska, on increased imports of pipeline gas from Canada (to the extent they are available), and on LNG from sources in Latin America, the Caribbean, Africa, the Middle East, Australia, and Russia.

Projected supplies of LNG imports assume that additional regasification capacity will be permitted and constructed either within the United States or in areas proximate to U.S. borders an uncertain assumption. In addition to environmental, safety, competition, and siting issues, opponents of additional LNG regas projects increasingly name security and foreign policy concerns about exposing the U.S. electric grid system to reliance on imports from countries, many of whom are oil exporters found in troubled regions of the world.

GLOBAL ENERGY RESERVES

Government owned or controlled companies control 72 percent of the world's oil reserves, 55 percent of the gas reserves, and more than half of the current world production.⁴ While two-thirds of the world's proven oil resources belong to OPEC members and 60 percent are found in the Middle East (Figure 4), non-OPEC producers, including the United States, Russia, Mexico, and Norway, currently provide significant global volumes, and will likely continue to do so for decades to come. As these resources are depleted, however, the world increasingly will come to rely on OPEC sources, in part as a function of their substantial reserves bases and partly the result of more favorable economics. Yet, these are sources where transparency issues and reserve numbers have been questioned and where production is generally controlled by national ministries or national oil companies (NOCs). Except under limited circumstances, these resources are currently inaccessible to international oil companies (IOCs).

Russia, Iran, and Qatar, the three top countries for natural gas reserves, contain almost 60 percent of the world's total (Figure 5). By contrast, the United States, Canada, and Venezuela account for just over 6 percent. OPEC member countries contain about half of global gas resources.

Examining the list of major gas reserve holders highlights two facts: first, natural gas reserves throughout the world are ample; and second, much of this supply is "stranded," that is, far removed from major consumption centers. As a consequence, gas transportation becomes a prime consideration one that is accomplished either through overland pipeline routing or by cooling and liquefying the gas to move it in sea-borne tankers.

The United States, Russia, and China hold over half of the world's proven coal reserves (Figure 16). The advent of truly "clean coal" technology and the world's ability to deal effectively with the environmental concerns related to mining and mining waste, could substantially improve coal's role in power generation, reduce natural gas demand (possibly freeing up supplies for transport uses), and improve efficiency.

RECONFIGURING THE GLOBAL ENERGY MAP—A NEW GAME FOR OIL

In the future, technology advancements and policy choices which re-rank security, environmental impacts, and foreign policy considerations could substantially alter the global energy mix and promote different fuel choices over traditional forms. That

⁴James Boxell and Kevin Morrison, "Oil Majors Find New Rivals Snapping at Their Heels," *Financial Times*, December 8, 2004.

possibility may also have the impact of reconfiguring the global energy map, creating new regional and international commercial and strategic alliances, altering the environment, and changing the way in which the world generates, transmits, transports, and consumes its energy resources.

The emergence of new regional and international commercial and strategic alliances may similarly mark the beginning of a “new game” in the geopolitics of oil. Although the implications for IOCs and especially for U.S. oil companies are not yet fully evident, this change comes at a time when access to new opportunities is a principal driver behind most corporate plans. That coincidence presents an unwelcome complication.

Evidence of this new game may be found in the activities of the national oil companies of China and India, exploring the globe in search of equity oil. Deals are struck on a bilateral basis, often secured through the granting of considerable foreign aid to host governments. Moreover, political commitments between the representative governments, sometimes hidden, sometimes not, add a worrisome element.

China currently receives 6 percent of its oil imports from Sudan and 15 percent from Iran. It is entirely conceivable that as a consequence of this oil dependence China could be expected to use its Security Council veto should the United States or other UN members attempt to impose oil-related sanctions on either nation.

Similarly, in Russia where it is widely believed that oil and gas development will serve as the engine for broader economic growth, President Putin appears committed to ensuring that control over those resources rests in state hands. While Russia, in the past, has declined to play politics with the export of oil and gas to the West, it is not implausible to assume that those resources may now be used in a manner that advances the country’s national interests, sometimes discreetly, sometimes not.

The viability of OPEC is questioned from time to time. While cooperation is easy to achieve during times of high oil prices, declining prices have member-countries concerned over their continued ability to meet internal budgetary requirements, taking actions that serve their own national interests rather than that of OPEC as a whole.

Three factors may shape the future of OPEC. First is the conventional wisdom that oil prices have moved to a new level, above the \$22-28 target; and that, absent any precipitous drop in demand, they are likely to stay high for some time.

Second, the disappearance of OPEC spare producing capacity (currently at its lowest level in 30 years), and the unwillingness or inability of member-countries other than Saudi Arabia to expand measurably producing capacity beyond expected market requirements, supports continued oil price volatility.

Third, in the coming decade, Libya, Iran, and Iraq are expected to be in a position to substantially ramp up production volumes and consequently seek higher OPEC export quotas. If global demand is insufficient to accommodate those incremental volumes without disturbing other member quotas, how will OPEC as an institution react?

EIA forecasts global oil supply in 2025 to exceed current production by some 46 percent or over 38 mmb/d. To achieve this level, production increases are required from both OPEC and non-OPEC sources. In the near to mid-term, increases in non-OPEC volumes will likely come from Canada, Mexico, Angola, Azerbaijan and Kazakhstan. Meeting this target will also require OPEC volumes to substantially increase. While there is a high level of confidence that the region contains reserves adequate to meet these targets, the strain on resources, supporting infrastructure and political governance should not be underestimated.

In forecasting future OPEC output, considerable attention must be paid to the pace and success of expansion efforts in Iraq, Iran, and Libya three countries in which the oil sector has largely been neglected for decades as a consequence of political upheaval, war, nationalization, and sanctions. In 1979, combined OPEC production capacity exceeded 38 mmb/d. Twenty-five years later capacity had declined to around 31 mmb/d (Figure 7). Two-thirds of that capacity loss can be traced directly to declines in those three countries. At the same time, Saudi capacity is roughly the same today as it was 25 years ago.

The growth in oil production from non-OPEC sources has significantly contributed to the marked erosion in OPEC market share since the late 1970s, as have gains in energy efficiency. That trend may be changing. Despite the emergence of a wider variety of producer nations, including new production from Latin America, the Caspian, Australia, West Africa, and nonconventional oil from Venezuela and Canada, plus the sharp rebound in Russian oil production, future growth, especially by 2020 and beyond, is likely to be overshadowed by production gains from the resource-rich Middle East.

It is here that the question of sustained demand looms particularly large. In 2003, both OPEC⁶ and the IEA projected that the average growth in global demand for oil over the next several years would approximate 1.6 percent per year. If true, worldwide incremental demand for oil would increase by almost 10 mmb/d by 2010. At that pace, virtually all new production from both OPEC and non-OPEC sources would be needed to keep pace with demand.

Assuming, however, that sustained higher prices may reduce that growth to 1.1-1.2 percent annually over the same period, additional worldwide production of only about half that much would be required.⁷

Under those conditions, non-OPEC oil production, including output from Russia, the Caspian, West Africa, and others, coupled with renewed efforts in Iraq and Libya, for example, would undoubtedly produce downward price pressure on other OPEC members and OPEC as an institution (in terms of quota enforcement). This could result in a particularly difficult time for Saudi Arabia during a period in which the Kingdom is expected to face substantial challenges in terms of population growth, governance, and political succession issues—a time during which sustained high revenues generated by oil exports will likely be needed.

MAJOR GLOBAL OIL PLAYERS

We can identify six key players in today's world oil market: Saudi Arabia, Russia and Iraq as "Givers" to the market, and the U.S., China and India as major consumers or "Takers."

Saudi Arabia

Saudi Arabia is likely to continue as world's largest oil exporter for at least the next few years, though Russia could pose a challenge in terms of gross production. Saudi Arabia is one of the few countries which possesses additional spare production capacity and is capable of expanding that capacity (at least on a temporary "surge" basis) in the near term.

Notwithstanding this enviable position, or possibly because of it, concerns surrounding Saudi output continue to abound. Terrorist threats to Saudi production and export facilities have increased upward pressure on crude oil prices and the Kingdom's aging leadership with no clear succession beyond the current Crown Prince, who is 80 years old, remain cause for concern.

In addition, the Kingdom's growing and youthful population, the tension between religious conservatives and more reform minded factions, high unemployment, and the increasing need for ever higher earnings to pay for health care, education, and infrastructure will require all the skills of the royal family to maintain social order.

Even with its then substantial oil export revenues, the Kingdom ran budget deficits until as recently as 2002. Notwithstanding current high production and prices, Saudi officials remain concerned that with the rise of Russian and Iraqi oil production and the re-emergence of Libya, in the absence of continued robust oil demand, OPEC producers and Saudi Arabia in particular could face reduced output and/or lower prices in the next several years.

Terrorism is the most public and immediate threat to the Kingdom and the royal family, not to mention the world oil market. Asset and personal security have improved over the year, in part due to collaboration and assistance from the government's foreign partners. While public support for terrorism is low and improved security may have reduced the chances of a successful attack, the threat has not been removed.

Political reform, despite its seemingly glacial pace, is also underway. The government is pursuing an announced process with specific markers, although it is not prepared to offer the ultimate democratic objectives sought by some in the West. In many ways, the U.S. declaration of bringing a wave of democracy to the Middle East may have exactly the opposite effect in terms of the pace and direction of reform in the Kingdom.

Russia

The Soviet Union entered the world market as a small net exporter in the late 1950s. During the next decade as production and export volumes grew, application was made for membership in OPEC. That gesture, however, was rebuffed although at OPEC's invitation, Russia now attends the cartel's official meetings with observer status.

Over 30 years, Soviet oil production increased from 2.3 in 1958 to more than 12 mmb/d in 1988, but export volumes remained relatively low, partly as a result of

⁶ *Monthly Oil Market Report*, December 2003, OPEC.

⁷ Extracted data from IEA and EIA reference and low economic/high price cases.

low domestic prices that encouraged wasteful consumption, and partly due to system loss. With the collapse of the oil sector in the late 1980's-early 1990's, Russian oil production declined rapidly from its 1988 peak to a low of some 6 mmb/d in 1996.⁸ This decline was unprecedented in world oil history, in that it was brought about not by developments in the market place, but rather by oilfield mismanagement and the lack of investment capital.

Following a decade of difficulty and turmoil, new investment has produced a marked increase in Russian oil output to about 9.2 mmb/d in 2004, allowing Russia to challenge Saudi Arabia as the world's leading oil producer. Internal consumption of approximately 2.4 mmb/d limits current exports to 6.7 mmb/d.

More importantly, until the recent crackdown on Russian producers, especially the embattled company Yukos, and the reassertion of Kremlin control over energy policy, output and exports (via infrastructure), estimates for future Russian production indicated continued and substantial growth possibly reaching as high as 12 mmb/d in 2025⁹—assuming continued high prices and successful exploration and oilfield development in the intervening years.

Russia's ability to continue to increase production rests on several considerations. Existing oil production, in part, reflects Soviet technology and practices. Production practices are suspect and the ability of the existing fields to sustain increased output is an open question.

The Putin government's strategy of restoring state control if not ownership of the oil and gas producing and infrastructure sectors, including its effort to insert favored companies into existing joint ventures, reflects a restoration of greater centralized direction. Overall, there is a widespread perception in the industry that large Russian producers desire foreign partners for financial reasons but are unwilling to relinquish control or ownership. Smaller Russian companies, on the other hand, hope to attract foreign partners as they provide the only available option for growth and new capital.

These developments raise the prospect that Russian production from existing fields may be nearing a temporary peak. Without additional incentives or early development of additional prospects, the recent history of rapid increases may not be sustainable. Future increases in the export of oil and gas in large part will depend on the timely discovery and development of new deposits in Eastern Siberia and offshore, on the availability of supporting infrastructure, and on IOC involvement contributing funding, technical and managerial know-how. Moreover, and of equal importance, the investment climate must be attractive and the rule of law must be in place, and honored. Risk-averse management may look elsewhere, while other corporations may value access over what is normally viewed as acceptable risk.

Iraq

The timing and success in stabilizing Iraq may well be one of the largest wild card issues with respect to global oil supply and prices. Iraq currently holds the world's second largest proven reserves of oil (at 115 billion barrels) and most industry observers speculate that with renewed investment directed to oilfield exploration and development, plus access to advanced technology and infrastructure improvements, the country could become a major oil producer/exporter. Realizing that future, however, will require substantial improvements in infrastructure and security, rule of law, and a thorough examination of the state of the major producing reservoirs in both the north and south (soon to be undertaken as a result of recently awarded contracts to Shell and BP). In addition, while the country is saddled with significant external debt, including billions in compensation claims resulting from the invasion of Kuwait, these financial obstacles are not expected to prevent investment from going forward.

Infrastructure security is especially important. Pipelines in Iraq have been blown up over 170 times since the President Bush's declaration of the cessation of major hostilities in May 2003. These incidents disrupt oil production and export schedules and bring about considerable financial loss to the country. This week's elections, while a significant step forward in the march toward democracy and nation (re)building are not expected to bring an end to the violence and sabotage.

Other Suppliers

There are also other groups of emerging producers. Over the last ten years substantial new exploration has taken place in the Caspian region, where significant production and exports are about to become a reality. Kazakhstan and Azerbaijan

⁸"Russia Country Analysis Brief," EIA, May 2004, www.eia.doe.gov/emeu/cabs/russia.html.

⁹Tables D5: World Oil Production Capacity by Region and Country, High Oil Price Case, 1990-2025," *International Energy Outlook 2004*, EIA, p. 217.

possess substantial resources, but as domestic consumption is quite limited, the timely development of these resources has depended on the availability of export pipelines to move oil and natural gas to hard currency markets.

A pipeline to carry Kazakh oil to an export site on the Black Sea has been available for several years now and is key to production reaching the stated goal of 3.5 mmb/d by 2015.¹⁰ Later this year, the Baku-Tblisi-Ceyhan (BTC) export pipeline will become operational, allowing expansion of fields offshore Baku.

Libya has recently proposed terms for production sharing agreements (PSAs). While expansion plans out to 2010 are comparatively modest, the removal of sanctions in a tight global oil market has made the country more attractive to investors. Even facing difficult contract terms, companies are still anxious to re-enter Libya.

West African oil provinces, at first glance, seem well-positioned to respond to U.S. oil import needs. The relatively short, direct route across the Atlantic Ocean to East Coast ports combined with superior crude quality lead many to suggest that West African exports can help the United States reduce its dependence on Middle East oil. Investment in heavy oil processing globally, however, may change the dynamics of West African marketing. Wide spread corruption, a personalized political system, lack of reform, and the failure to equitably redistribute the financial benefits of oil export revenues have created conditions conducive to civil unrest that often interferes with oil production and export schedules.

NONCONVENTIONAL SUPPLIES

Nonconventional energy supplies (heavy oil and tar sands) in Canada and Venezuela hold considerable promise, but also face substantial obstacles. Development of the Canadian oil sands requires tremendous amounts of water and natural gas and is very labor intensive. Extraction is largely a mining operation and two tons of oil sands are needed to produce one barrel of oil. At present, these oil sands yield roughly 1 mmb/d.

The heavy oils of Venezuela face their own challenges. Yet given the enormity of the resource base, even in the face of the recent announcement of hefty royalty increases, investors still look favorably (albeit cautiously) on prospects for development.

GLOBAL GAS & LNG

Global gas reserves are abundant and given recognition of natural gas as an environmentally friendly fuel and the desire of resource holders to monetize their resource, it is not surprising that forecasts for gas supply and demand over the next decade are frequently described as robust.

Unfortunately, much of this gas is considered stranded as it is located in areas geographically distant from major consuming areas. In some cases, overland piping of gas is economic, but for transiting great distances, including across ocean expanses, liquefying the gas and shipping it in sea-borne tankers is becoming an increasingly attractive option. IEA projections for gas demand growth indicate that natural gas will overtake coal as the second leading energy fuel source sometime in the next decade. By 2030, more than 50 percent of all inter-regional gas trade will be comprised of LNG shipments.

In 2002, twelve countries (Algeria, Libya, Qatar, Nigeria, United Arab Emirates, Oman, Australia, Brunei, Indonesia, Malaysia, the United States, and Trinidad and Tobago) shipped some 5.4 trillion cubic feet (tcf) of gas to about the same number of countries worldwide. Supplying markets in just three countries Japan, South Korea, and Taiwan accounted for two-thirds of the total LNG demand. Three additional exporters (Russia, Norway, and Egypt) are constructing liquefaction facilities and at least seven additional producer/exporters (Iran, Yemen, Equatorial Guinea, Angola, Venezuela, Bolivia, and Peru) are waiting in the wings.¹¹

Unlike oil investments, however, LNG financing and project success ultimately are tied to consumer markets. Siting and permitting approvals, especially in the United States, are not guaranteed. Environmental, safety, and security concerns remain largely unanswered and policy issues surrounding the prudence of exposing the domestic electric grid to the same or similar price and supply volatility recently experienced in the oil-based transportation sector may dampen enthusiasm for needed natural gas imports, possibly to the benefit of domestic coal.

¹⁰ See official statement by Uzakbai Karabalin, President of Kazmunaigaz National Oil Company, October 2003, www.kazakhembus.com/100203.html, and *Kazakhstan Country Analysis Brief*, EIA, November 2004, www.eia.doe.gov/emeu/cabs/kazak.html.

¹¹ "Natural Gas," IEO 2004, EIA. pp. 47-74.

The United States

The role of the United States as an energy producer, consumer, and importer has already been noted in some detail. The energy future of the country seems at once very clear but very worrisome: declining domestic production and rising domestic demand, with the gap to be covered by imports from suppliers whose national interests may not and historically have not coincided with U.S. interests.

This almost inevitable growth in reliance on foreign supplies would, to the casual observer, seem to be a call to action, to define and implement policies that would concomitantly expand domestic supplies while setting demand management efforts in motion. To do so, however, requires a certain political will on the part of both the U.S. consumer and the government. And, to date, despite higher energy prices, threats of shortage, environmental damage and blackouts, that critical ingredient remains lacking.

All energy producer/exporters and consumer/importers are bound together by a mutual interdependency. All are vulnerable to any event, anywhere, at any time, that impacts on supply or demand. This means that the U.S. energy future likely will be shaped, at least in part, by events outside of its control and beyond its influence. Calls for energy independence, absent major technological breakthroughs and a national commitment, ring hollow and in the near term are both unrealistic and unachievable. In the absence of decisive political will to undertake those steps necessary to improve efficiency, promote conservation, the increased use of domestic energy resources and renewable energy forms, learning to manage the risks accompanying import dependency may be the only reasonable course of action.

Further, it should be noted that while the United States currently imports roughly 23 percent of its crude oil needs from the Persian Gulf, if total reliance also took into account the indirect imports of manufactured goods from other nations that also purchase Middle East oil, the resulting figure might be 30-40 percent higher.¹²

China

The analytical community is in almost universal agreement regarding the size and nature of Chinese energy demand growth over the next three decades. It will lead the world with growth rates substantially above the world average. All sectors of the energy producing economy are predicted to grow between 2.3 and 9 percent while generally maintaining the current share of each within the total fuel mix. Coal would retain its dominant position in this scenario.

Growth rates of this magnitude would drive world oil and, to a lesser extent, natural gas markets as imports of both are projected to increase substantially. Foreign investors and suppliers are eager to exploit this potential and Chinese officials are taking advantage of this interest.

As demonstrated by almost 30 years of economic reform and growth, Chinese decisionmakers are likely to proceed incrementally in further reforming the energy sector. The result is an existing energy sector containing a mix of market signals and government direction. For example, power stations pay close to market prices for coal but are unable to pass on the full cost to consumers.

China's mixed economic system complicates introducing new market related policies for a variety of reasons. Any decision may worsen existing distortions. Equally important, any decision is guaranteed to diminish the authority of those directing the system as well as those who benefit from the status quo. This latter problem may prove particularly intractable if both producers and consumers benefit from the status quo.

China's current five-year plan ends in 2005. A group of senior advisors, comprised of academics, senior statesmen, and business leaders is considering a revised energy strategy to cover the period to 2020. There are undoubtedly differences within the group over how to meet the announced goals of energy supply security, environmental protection, economic efficiency, and rural development, not to mention the implied need to maintain domestic tranquility.

Energy investors have a vested interest in any decisions made. There is for example a need to rationalize and modernize the refining sector while ensuring the delivery of product to rural or underserved areas. Similarly, there is a need to rationalize the domestic energy pricing system not just for consumers but also to effect market competition for competing energy sources.

¹² Anthony Cordesman, *Saudi Petroleum Security: Challenges & Responses*, CSIS draft, Washington, DC, November 2004, p. 7.

India

India contains 16 percent of the world's population, a growing thirst for energy in support of its expanding economic growth, but only a very limited resource base to call upon. Oil use rose by a bit more than 1 million b/d during the 10-year period 1993 to 2003, but domestic oil production was able to cover just one-third of that increment. The gap could only be filled by expanding the importation of foreign oil, which now accounts for some 70 percent of the country's current oil needs. There is little reason to believe that any import relief can be secured, and the IEA places India's oil import dependence at 80 percent as early as 2010.

This high degree of dependence on foreign oil troubles the Indian government. As a consequence, the country is seeking to diversify its energy base while undertaking a broad-ranging and aggressive search for equity oil around the world. Interestingly, this search has on several occasions put India in direct competition with China. Limited opportunities worldwide confirm that this competition likely will continue.

Competition for access to oil supplies typically occurs between private companies. When governments, through national oil companies, increase their involvement in competition, both the nature of the issues and transparency regarding the terms may be sacrificed.

The natural gas resource base of India is equally limited, and for both oil and natural gas, the ever-increasing gap between domestic supply and demand will have to be covered by imports. India must look abroad for incremental supplies production currently determines how much natural gas can be made available, and these volumes fall well short of the country's realistic needs. In this effort to search out and find acceptable sources of natural gas outside India, pollution abatement is just as much a driver as is diversity among fuels consumed.

GEOPOLITICAL CONCERNS

Does this new oil "map," the emergence of China as a major competitor (the number 2 importer and consumer, behind the United States), and threat of realignment and bilateral arrangements threaten traditional global supply network? Should the U.S. government be concerned if China and Russia or China and the Middle East form diplomatic alliances and bilateral relationships? How would such action affect U.S. foreign policy options, especially regarding Sudan and Iranian sanctions? How plausible? Is the recent Saudi decision to supply China and reduce exports to the United States purely economic (given demand, crude quality and price differentials) or something more political in nature? Can a change in U.S. policy toward the Middle East peace process improve the U.S. Saudi relationship? How will the upcoming elections in Iraq affect the region?

More importantly, under all forecasts, energy import dependence in Japan and China will increase. Part of this supply will come from Russia and part from Africa, but the bulk will come from the Middle East. Seeking security of supply through diversity of suppliers, in the past several months, the Chinese government has discussed commercial or diplomatic arrangements with Russia, Kazakhstan, Saudi Arabia, Iran, Venezuela, Canada and Argentina. Should this be a wake up call and cause for concern?

PRICE VOLATILITY AND THE CURRENT OIL MARKET

Crude oil prices have increased by over 60 percent since the beginning of 2004. As a consequence, the past few months have also seen near record prices for refined petroleum products (gasoline and distillates) in the United States. While oil price volatility is seen often as a recent phenomenon, evidence over the past thirty years (Figure 8) suggests that price volatility has been the rule rather than the exception. Most of the upward price movements have been tied to oil supply disruptions and political upheaval. The 1973 spike was the result of a targeted embargo against the United States.

Conversely, when prices drop precipitously, it is usually the result of intentional or unintended oversupply. At times this has been caused by deliberate Saudi efforts to regain control of the market. Other price collapses were caused by demand reductions resulting from high prices (early 1980s) or economic recessions (Asian recession of the mid-1990s).

The current oil market, however, has been driven by a number of specific factors, including:

- Unexpected high demand growth in the United States and Asia, particularly in China;
- The marked absence of adequate commercial inventories (supplemental sources of supply);

- Limited spare production capacity on the part of the major producing nations;
- Uncertainty in the ability of producers to continue to deliver needed oil volumes to the market—a situation exacerbated by *actual* disruption in supply from Venezuela, Norway, Nigeria, the U.S. Gulf Coast, Iraq, and the concern over further losses from Venezuela as well as a *potential* loss of supply from Saudi Arabia and Russia; and
- The role of speculators.

A decided mismatch between the types of crude available for sale and those needed by refiners and buyers to produce consumer products has complicated the supply picture. This crude quality issue was most evident in the price spread between light sweet crudes and heavier, sour oil and in the request for light oil swaps or loans from the SPR that followed the loss of domestic production from the Gulf of Mexico as a result of Hurricane Ivan in September 2004.

Looking ahead into 2005, market fundamentals are likely to change very little. Sizable new (incremental) production is not expected until the latter half of this year at the earliest. Owing largely to the lag time between investment and output, additional production growth is not expected until 2007 and beyond. Consequently, if global demand continues to grow, albeit a bit more slowly than in 2004, partly as a result of weakened economic activity reflecting higher prices, supply/demand balances can be expected to remain tight but manageable for at least the near term. In this scenario, barring any significant and protracted loss of oil output, oil prices are likely to recede from current high levels but remain in the \$35-45/barrel range, while exhibiting continued volatility in reaction to specific events.

Alternatively, should sustained high prices result in a regional or global economic slowdown, demand reductions will have to be countered by OPEC production cuts to maintain price levels. Conversely, if prices moderate, we expect a corresponding increase in demand, continued tightness in supply availability and the prospects for substantial price increases if supply shortfalls become evident.

Increasingly, economic forecasters are projecting a reduction in U.S. and global GDP growth for 2005-06 as a result of sustained high oil prices. Regional economic impacts vary depending on the level of oil dependence of particular countries, their ability to substitute or reduce their oil consumption, and calculations based on achieved energy efficiency. At the very least, higher oil prices will have the effect of dampening the cyclical upturn in global economic activity.

OIL IN THE FINANCIAL MARKET, INTER-REGIONAL TRADE AND CHOKE POINTS

There may be no clearer indicator of energy's role as a strategic commodity and the interdependency of participants in energy markets than an examination of oil's role in global trade and finances. In today's global oil market, after netting out volumes produced and consumed in the same country, somewhere on the order of 35-37 million barrels are actually transferred internationally on a daily basis. At an average price of \$45 per barrel, that adds up to slightly more than a billion and a half dollars a day. Daily U.S. crude oil imports cost more than \$450 million or over \$160 billion annually.

The transfer of wealth from the industrialized world to oil producer/exporters is without precedent. During the past 30 years OPEC's (net) export revenues have increased tenfold from under \$30 billion to almost \$340 billion (estimate for 2004). In the last ten years, oil export revenues have doubled for every OPEC member, and tripled in the case of Qatar.

More importantly, given rising global oil demand, the IEA's World Energy Outlook 2004 projects that inter-regional trade in oil shipments will increase sharply by 2030, reaching 65 mmb/d, accounting for more than half of global oil production and roughly double current shipments. As a result of growing concentration in production and exports from the Middle East, increased tanker traffic to major consumption centers around the world will necessarily increase routing through recognized "choke points," major transport channels through which much of the world's oil (and LNG) currently flows. As these routes are highly trafficked and pose navigational challenges, they are also areas susceptible to piracy, terrorist attacks, or accidents.

EIA and IEA sources have identified six such strategic maritime choke points and several major pipeline systems. Those that affect oil and LNG tanker traffic are:

- The Straits of Hormuz, located at the mouth of the Persian Gulf, currently the world's most critical maritime oil-shipping route;
- The Straits of Malacca, located between Indonesia, Malaysia and Singapore, and the principal route for oil shipments to Asia;
- The Suez Canal, which connects the Red and Mediterranean Seas;
- The Bab el-Mandab passage, connecting the Red Sea and the Gulf of Aden;

- The Bosphorus and Turkish Straits, connecting the Mediterranean and Black Seas and a major waterborne shipping route for Caspian and Russian oil; and
- The Panama Canal.

Collectively, over 34 mmb/d of oil is shipped through these channels every day. Disruptions at any of these choke points would undoubtedly have a dramatic impact on crude deliverability and prices. More importantly, as global oil trade expands, these major arteries will become even more critical and heavily utilized. In fact, IEA projections forecast that tanker traffic through the Straits of Hormuz and Malacca and the Suez Canal alone will more than double by 2030.

CHALLENGES FOR INTERNATIONAL OIL COMPANIES (IOCS)

When confronted with the prospects of continued near-term tightness in conventional oil markets and corresponding high prices, instability in major oil producing areas, heightened sensitivity to national security concerns, the need to improve environmental conditions while continuing to offer reliable energy choices to developed and developing economies alike, IOCs are now faced with a spectrum of strategic investment choices. These include pursuing access to conventional energy resources and/or moving to develop nonconventional fuel forms, including LNG, GTL, renewables, and biofuels, in concert with traditional and emerging energy suppliers.

Since the majority of today's proven oil reserves are located in a handful of countries with access controlled by national ministries or national oil companies, the ability of the IOCs to successfully pursue access opportunities is currently severely limited. This situation is exacerbated by current high prices as these translate to high export revenues for major producer countries and undermine the need for outside assistance. Flush with the income from higher oil prices, host country producers are less likely to require or desire the assistance of foreign oil firms, except in the instance of acquiring technology-specific aid enhanced oil recovery efforts, for example. Higher prices and profits generally also translate into tougher commercial terms for entrants as host governments look to extract additional concessions from bidders.

Assuming that companies are denied access to conventional oil reserves in OPEC nations, IOCs are left to choose among investment options in non-OPEC countries and frontier areas (e.g., ultra-deep water and the Arctic), pursue nonconventional fuel choices, focus on research related projects to develop renewable sources and/or pursue technology and demand reduction initiatives that preserve the continuity or expansion of their product line. This alternative strategy is not without risk, however, and even large IOCs are expected to experience difficulty in replacing reserves in the coming years.

POLITICAL AND OTHER TRENDS

International politics and the political environment within which companies operate are also undergoing fundamental change. For companies looking to invest or trade, an issue of paramount concern is the country's governing structure and the locus of political authority. And the predominant, emerging political ideology of this century has become autonomy, with its increasing emphasis on unique identities around shared ethnic, cultural, or religious values. This new ideology poses a challenge to the old system of nationalism and the traditional nation-state. As a consequence, investors are witnessing the growing power of non-state actors and the increasing likelihood of precipitating events leading to the overthrow/overhaul of ruling regimes. In energy producing countries, the importance of the energy sector invariably means that it is almost always in play politically.

Governments facing political threat or transformation respond in varying degrees with a combination of coercion, co-option and cooperation. Some resist claims for autonomy by reasserting central control and direction often at the expense of market efficiency. States in which political authority and economic control is shared among a small group of individuals and interests resist threats to their control most vigorously. Consequences for investors are most severe in instances where the domestic confrontation results in an abrupt and violent political transition as occurred in the past in Iran, Iraq, Libya, and Venezuela. Under those circumstances, oil production declines dramatically, usually failing to regain its pre-crisis levels for a decade or more. Further, in most cases, private assets are taken by the state.

On the economic front, market capitalism appears to be losing ground to economic ideology. The appeal of economic efficiency and reliance on the market, which resulted in the rapid spread of domestic market reforms and global financial, trade and investment integration in the 1980s and 1990s, has stalled. For the oil sector, domestic economic reforms were welcomed as they permitted foreign investment and even some limited privatization.

Citing justifications of security, jobs, environmental concerns, economic competition and the narrow need for securing energy supplies, certain nations have slowed reforms and are beginning to pursue more centralized ideologically-justified, interventionist economic policies, often with widespread domestic public support.

The confluence of these political and economic changes holds several major implications for energy investors. First, to the extent that IOCs continue to be denied access to those few select resource-rich nations under competitive terms comparable to those offered elsewhere, their E&P investment opportunities are likely to become more complicated, causing investors to continually rebalance their portfolio risk, including the addition of less attractive opportunities, with potentially longer payout periods. Portfolios of the future will likely include fewer commercially attractive exploration opportunities in frontier areas, workover acreage offered by nations attempting to forestall production declines by offering more attractive terms to new entrants, and possibly a few lower return but highly prospective areas.

Coupled with the difficulty in obtaining access to proprietary reserves is the emergence of significant competitors pursuing investments in the most attractive exploration and production markets. As previously discussed, the most aggressive of these new competitors is China, and to a lesser extent, India. And this raises a third challenge, namely dealing with the reemergence of security inspired, politically driven foreign investment.

Over the past few years, Chinese state companies, in particular, have aggressively gained access to prime production opportunities using their lower cost of capital and the financial and political support of the Chinese financial institutions and government. These companies tend to make uneconomic bids, use Chinese state bilateral loans and financing, and spend wildly. Chinese investors pursue market and strategic objectives, rather than commercial ones.

In strategic terms, the Chinese government has artfully exploited the reduced U.S. political standing among oil producers (and its overuse of economic sanctions) to assert its strategic interest in the Middle East. Since China is unable to project significant military forces in the Gulf, it employs economic, commercial and political means instead. It is also seeking access to higher quality crudes that better match the configuration of its refining sector.

China also offers the attractiveness of its rapidly expanding energy consuming sector to leverage suppliers and investors to accept lower returns and to provide desired technology as the price for entry to both the downstream and LNG markets. In this way, China is redefining market competition.

The consequences of the Chinese strategy are to reduce investment opportunities for commercial entities and ultimately reduce the flexibility of the global crude trading market. While the implications of this strategy have not gone unnoticed, the United States has been slow to recognize the dynamics of this potentially changing market.

IMPLICATIONS FOR U.S. POLICY

Over the past 50 years, U.S. energy policy has been faithfully diverse, often internally inconsistent, amazingly flexible in adjusting to public, market and commercial pressures, and incomprehensible to most observers. It is likely to retain many of these unique elements.

The 1970s provided the last clear articulation of an attempted national energy strategy and this was largely in response to global energy events. The 1973 Arab Oil Embargo prompted the development of the SPR, the adoption of CAFE (Corporate Average Fuel Efficiency) standards, and the formation of the IEA. Domestic natural gas shortages and the prospects for declining oil supplies produced the Carter Administration's decision to lift oil price regulation and pursue energy sector transformation, ushering in a new era in U.S. policy driven by the market. The combined effect of these actions has produced the following results:

- Consumers pay market prices for oil and gas and market responses are favored to adjust to price distortions and to distribute oil;
- With some narrow exceptions, economic regulation is a policy of the past;
- The United States remains the largest and most attractive import market for suppliers of all types of oil and gas, ensuring oil supply diversity and relatively robust levels of natural gas imports. A policy inclination for regional or Western hemisphere oil supplies has been largely discredited, but nonetheless remains alive; and that policy may be revived in the face of global security threats;
- Refiners have successfully responded to environmental legislation by closing inefficient refineries and investing in increased capacity to produce new products, using lower quality crude oil;

- The SPR is nearing capacity and a heating oil reserve in New England now exists;
- All administrations have been committed to the multilateral political arrangements contained in the IEA. International cooperation in oil is enshrined, if not always practiced, in the face of world market shortages; and
- On a bipartisan basis, successive administrations have supported U.S. investors negotiating contracts, particularly in non-OPEC countries and with natural gas producers.

In short, economics has prevailed over the past 25 years. Oil prices have remained relatively low and U.S. energy efficiency has increased. However, changing market and political conditions may complicate America's policy agenda going forward, and these include:

- Energy security, broadly defined in terms of attacks on infrastructure, and greater vulnerability to imported oil supply threats, either physical or financial, due to growing production concentration;
- Market developments, particularly in alternative fuels and with respect to climate change. In the future, markets may drive policy more than policy drives markets;
- Less multilateral cooperation in the international oil trading and investment market places as governments pursue specific narrow interests;
- Increased vulnerability to supply disruptions due to growing natural gas import dependence in the power sector; and
- Political hostility to U.S. policy in specific regions as allies and friends abandon the United States to ensure their own political survival.

It is against this backdrop that future U.S. energy and security policies must be fashioned. But that is likely the topic for another day.

Thank you.

The CHAIRMAN. Thank you very, very much.

First, let me say how pleased I am that so many Senators have attended. I cannot think of any hearing that could be taking place here in the Senate where more important and vital information would be available to Senators than what we have heard here today. I know you all are going to have a lot of questions and thoughts, and I am going to yield after a story. I just want to tell you what these four people remind me of. You will understand this very well, Mel.

When I was growing up, my father, who did not speak English very well, used to look out the window of his little office, and usually about once a week, a little bicycle would come up the sidewalk with a little driver. On the front of the bike, he had a little knapsack. In that knapsack, were whatever that fellow was bringing back to his business from the banks. He had sent something to the bank. They were sending something back. What they were sending back were the bad checks, the checks they had taken and deposited that were no good. And he nicknamed that little bike. He called it the pájaro de mala suerte. He laughed. You understood what it was. He called that little fellow the bird of bad luck, or bad luck bird. It sort of reminds me of these witnesses.

[Laughter.]

The CHAIRMAN. They are bad luck birds. If we pay attention to what they have said, anybody that does not think that they are at least that or more was not listening.

I have just two questions. Since LNG is so much in the wind here, would somebody tell me where is most of the basic resource for LNG? Where is it in the world, and how much is there?

Mr. CARUSO. Well, the main LNG suppliers today are Algeria, Trinidad and Tobago, and Nigeria, as well as the Asian suppliers, Malaysia and Indonesia. But there will be substantial increases, as

you can imagine, from the demand numbers you have just heard, and they will come from Russia, Norway, Qatar, and Australia, and there could be others such as Iran, for example. So they are similar, but not identical to the oil sources.

The CHAIRMAN. What is the effect going to be of the competition for LNG among large consumers like the United States, China, on the ultimate cost of natural gas? And could you describe some of the progress that we are making in developing LNG regasification terminals in other countries?

Mr. CARUSO. Well, the United States, of course, would be a major player. As you pointed out in your opening remarks, net imports of LNG in 2003 of .4 tcf to potentially 6.4. So we will clearly be a dominant player as you look out over the next 2 decades. Right now there is a regional market for gas.

The CHAIRMAN. My question is what effect will that have on the price of natural gas?

Mr. CARUSO. Yes. We think that with the kind of LNG exports that are projected in our outlook, as well as the IEA's outlook, that the price pressures on natural gas will be downward. We do think that by 2010, when a large component of new LNG comes into the United States, that the average wellhead price of gas in this country will go below \$4 a 1,000 cubic feet. It is about \$5.50 today. So we do think increased LNG supplies will provide some increased competitiveness in the United States, as well as on a global basis.

The CHAIRMAN. My last question has to do with nuclear power. Whoever talked about nuclear as part of the mix, I notice it did not account for very much by 2025. Is it possible that it could play a bigger role if the process for the development and licensing of nuclear power plants was substantially different than history has revealed?

Mr. CARUSO. Yes. Our outlook is for there to be no new nuclear plants in our 2025 outlook, and that is mainly because the economics are unfavorable relative to combined-cycle natural gas or pulverized coal. It certainly is possible that that could change, but it would require both improvement in the economics, as well as some of the structural issues that you have mentioned. Clearly the potential is there. Some of the suppliers of nuclear plants do believe they can bring the cost down substantially, and our scenario that we will release next week shows that if they bring the capital cost of a nuclear plant down to about \$1,450 a kilowatt, that nuclear would be quite competitive particularly in the decade after 2015 to 2025.

The CHAIRMAN. Thank you very much.

Senator Bingaman.

Senator BINGAMAN. Thank you very much. Thank you to all the witnesses.

I would like to try to sort of disaggregate some of the information we have heard here. First, just to talk about oil. The growth in demand for oil, as I understand it, at least in this country is primarily a result of increased demand in the transportation sector. Is that accurate?

Mr. CARUSO. That is absolutely correct, sir.

Senator BINGAMAN. And is that true worldwide? Is that what is driving the growth in demand for oil that we are seeing in China and these other developing countries? Is that a fair statement?

Mr. CARUSO. Well, in our outlook it is a bit different outside of the United States in that it is more shared across sectors. So the industrial sectors in, particularly, China and other parts of Asia also show substantial growth, in addition to transportation. So it is more spread across the commercial and industrial sectors, as well as transportation.

Senator BINGAMAN. But is it fair to say in your opinion that any serious effort to reduce the demand for new oil, the increased demand for oil over the next decade or two will have to have as a central component reducing the demand in the transportation sector? Is that fair?

Mr. CARUSO. Yes, sir. It is our view.

Senator BINGAMAN. Now, the growth in the demand for natural gas, as far as I can understand it, here in the United States at least, is a result of the demand for gas to generate more electricity. So that is where that growth is coming from?

Mr. CARUSO. Yes, sir.

Senator BINGAMAN. Is that true worldwide also? Is the primary increased demand for natural gas worldwide coming from more and more plants being constructed to produce electricity with that gas?

Mr. LOGAN. It is partially true in China, but there are a whole number of emerging industrial and residential sectors that are, for the first time, using natural gas. So in China, and in India I think to some extent, it is more of a new playing field that is emerging.

Senator BINGAMAN. So I guess policies that would encourage or facilitate generation of electricity from sources other than natural gas would be helpful in reducing the future demand for natural gas. Is that a fair conclusion?

Mr. CARUSO. It is definitely true in this country, as well as in Asia.

Senator BINGAMAN. I think Senator Alexander was asking about the various proposals that are floating around and that we heard at this conference that we had a week or so ago about coal gasification and carbon sequestration as a way to facilitate the use of more coal in power generation. I guess just to try to understand the size of that problem, my impression is that given current plans, there are going to be a tremendous number of additional coal-fired power plants constructed over the next 10 or 20 years. China is planning another 500-and-some-odd, as I understand it. India has got several hundred. I do not know exactly how many, but the figure that I saw was that there were over 800 known, planned coal-fired power plants on the books somewhere, on the drawing board somewhere for construction.

It would strike me that on the global warming issue, which I think just about each of you has mentioned in passing, there is no way to deal with that issue in any meaningful way without trying to change the technology that is used in those new coal-fired power plants. Is there?

Mr. VERRASTRO. Senator, if I might. Just to put your comments in context, globally 40 percent of total energy consumed goes to power generation. It is the single biggest factor. About 20 percent

goes for transportation and half the world's oil. So if we have an 82 million barrel a day world, about 40 million barrels a day goes to transportation. If you do not attack transportation and power generation, you cannot even expect to make a dent in reducing demand or controlling it.

Having said that, on the power generation side in the United States, half of the power is generated from coal, 50 percent. About 20 percent comes from nuclear. 13 or 14 percent comes from natural gas. It is unbelievably inefficient. It takes three units of primary energy to produce one unit of electricity out the back end. If you could conserve or find alternatives to reduce the amount of total electricity consumption by improving efficiency, you obviate the need for three primary units at the front end, and that is a significant piece.

Your point on coal I think is extremely important. The United States is frequently identified as the Saudi Arabia of coal in terms of resources. There are many things you can do with coal, gasify it, liquefy it. Our transportation sector right now, the gasoline combustion engine runs on a liquid fuel. It is very hard to do and replace gasoline unless you have another liquid. If you can liquefy coal or gasify it with a clean coal technology and scrubbers, you can appreciably improve the environment and also change your energy mix.

Mr. SLAUGHTER. I would just like to comment on coal gasification, if I may, very briefly. At Shell, we believe in opening up options for the future use of energy by maturing technology, and I think coal gasification is certainly one we need to look at not only for the United States but for major coal-consuming countries like China which has both the resource and a need. We are actually developing technology in one of our units, Shell Global Solutions, which we are looking to license to utilities and electric power producers as it matures.

I think basically this fits into the whole concept that energy markets and energy market structures take a very long time to shift, and you have to take action early to mature new technologies to get them into the portfolio of choices. I think it is an ongoing process and we need to work on it.

Senator THOMAS [presiding]. Thank you.

Senator Martinez.

Senator MARTINEZ. I have concerns—and I would like for Mr. Logan perhaps to address this—in the area of the geopolitical world in which we live and the concerns that you expressed with the instability in some parts of the world. I know that there have some concerns that Venezuela could decide to sell their oil elsewhere. I do not know that that is necessarily practical in the short term, but I do know that there is an increasing interest in Venezuela and China in doing business with one another.

What would be the impact? How do we prepare for the possibility of a disruption of supply from Venezuela?

Mr. LOGAN. Well, I think that is a difficult question when you ask about one particular country. Our forecasts call for, in the future, more of a surplus, I guess, in the supply demand balance than has existed over the last year or so. So hopefully there would

not be an immediate global catastrophe if, for example, Venezuela happened to shut off its output.

But in a larger economic sense, Venezuela is very closely tied into the global market, and it would not really serve their interests to stop selling oil at the market price. So in a sense, they are tied into the system as it exists right now.

Senator MARTINEZ. So the likelihood of that occurring you do not think is a realistic possibility.

Mr. LOGAN. Well, it is very difficult to say. It is something we have to be prepared for certainly, but the likelihood I do not think is very high.

Senator MARTINEZ. That is all I have.

The CHAIRMAN [presiding]. Thank you, Senator.

Senator Wyden.

Senator WYDEN. Thank you, Mr. Chairman.

Mr. Caruso, in the last analysis that you all did, you indicated that the United States is exporting 1 million barrels per day of petroleum in 2003. Does that not make us something like 10 percent less secure every single day because we are, according to your figures, 9.6 million barrels per day dependent on foreign oil? And if we are exporting 1 million barrels out of the country, are we not 10 percent less secure every single day because of the conduct of the oil companies?

Mr. CARUSO. You are absolutely correct, we are exporting about 1 million barrels a day, according to our latest numbers, which go through 11 months of 2004. That is because, of course, we have free trade and we do not have restrictions other than some on crude. But about 950,000 barrels a day or more is in the form of refined products.

A large portion is petroleum coke, which is residue from refineries. I think last year we exported close to 400,000 barrels a day of petroleum coke which was excess. It was not really a critical component of our consumption mix. Most of that went to Asia.

The other big part of that million is about 150,000 barrels a day for cross-border trade with Canada. There are some markets that are on the border that would be more efficiently served by movement across the border.

So of the 1 million, maybe a little over 500,000 is explained by those two phenomena. The rest of it, of course, is just the market determining where those products could best be utilized. But, indeed, we calculate our import dependency on a net basis, and the figure I mentioned, 56 percent net import dependency, includes that million barrels per day.

Senator WYDEN. I would like you to supply for the record a list of the companies that are exporting these products outside the United States and the amounts they are exporting. Obviously, you have got it because you calculated it. Can you make that available to us?

Mr. CARUSO. Yes, sir.*

Mr. VERRASTRO. Senator, if I might.

Senator WYDEN. Let me just ask one question of Mr. Slaughter, and then I am happy to take yours, sir.

*See Appendix I.

My question to you, Mr. Slaughter, is why is industry tying up scarce refining capacity in this kind of way? Because you all have made the case that we do not have adequate refining capacity. It is something I happen to be fairly sympathetic to. But why are we using refining capacity now in a fashion that is apparently being used to export all these products rather than figuring out a way to make sure that the products stay in our country, gas and diesel? Why is this going on?

Mr. LOGAN. First, I am not a refining expert or do not represent the refining part of our company. But when you refine a barrel of crude oil in any particular refinery, you get a particular yield of products which come out of it, and that has to be balanced among all the available markets in accordance with the demand in those local markets by the refinery. And there is never a perfect correlation between end-use demand and the refinery output. So balancing trade actually makes the market work more efficiently.

Senator WYDEN. Well, it might make sense in some fanciful trade theory, but to me, anyway you look at it, we are 10 percent less secure. Mr. Caruso has told us that we are looking at 9.6 million barrels per day in terms of our dependence on foreign oil and we are shipping 10 percent of it out of the country because of some fanciful notions about trade.

I want to get into one other area, but I want to give you, sir, a chance to make your comment.

Mr. VERRASTRO. Thank you, Senator. Just to follow up on Andrew's point, I think there are two things when you talk about refining capacity and exports. One is that companies typically work our swap arrangements. They will supply a certain area that is geographically proximate to where they have refineries in terms of refined products and take product elsewhere. So some of that is netted out. It might just be a market switch where you move product and you get product back in return in some other market.

The second piece of that is when refineries produce a slate of products, some are usable in the market that they serve, some are not and they are excess to that market. And in the case of resid, for example, there are a lot of shipments in bunker fuels and asphalt.

Senator WYDEN. Do I have time for one additional question, Mr. Chairman?

The CHAIRMAN. Yes.

Senator WYDEN. Thank you for your thoughtfulness, Mr. Chairman.

Mr. Caruso, you can hear in my opening statement—I also serve on the Finance Committee—I am interested in changing the tax incentives for oil production. The Congressional Research Service considers the existing tax credit for enhanced oil recovery to be, in their words, a relatively inexpensive way to add additional oil reserves. Now, they estimate that nearly 400 billion barrels of oil remain in abandoned reservoirs, and that 10 percent of that oil consists of known recoverable reserves that could be produced with EOR techniques if the incentives were there. So we would be talking then about 40 billion barrels of oil that is in the ground that is not being recovered today that could be produced in the United States if there were the right incentives.

Would it be your view that an additional 40 billion barrels of oil would make a significant difference in reducing our dependence on foreign oil?

Mr. CARUSO. Certainly it would make a big difference. We have used enhanced oil recovery very effectively in this country, but even with that latest technology, we only recover about 30 percent of the oil in place.

Senator WYDEN. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Smith.

Senator SMITH. Mr. Caruso, did I understand your testimony correctly that you project significantly lower prices in the future in constant dollars than we are paying today? Is that what you said?

Mr. CARUSO. That is correct, Senator.

Senator SMITH. And is that true even in light of the rapid growth in China and other emerging nations?

Mr. CARUSO. That is our reference case and we have, as I mentioned, looked at several other cases which will be released next week in which we say, well, given the uncertainties that some of the other witnesses have referred to this morning, what if we are living in a higher oil price world, what difference would that make? Clearly it does make a substantial difference in things like coal gasification, for example, and coal liquification. So, yes, we have done that.

Senator SMITH. Your testimony indicates that about 70 percent of U.S. petroleum demand in 2025 will be for transportation uses. What assumptions did you make about CAFE standards, fuel cell vehicles, and hybrids that are emerging as very high demand vehicles among consumers?

Mr. CARUSO. The assumptions were the existing rules and regulations. So, therefore, any standards would be those that are in place as of November 2004 when we finished our analysis.

Senator SMITH. But the ones that are in the energy bill we almost passed, that are likely to pass in this Congress, those would improve the situation quite dramatically or would they be marginal?

Mr. CARUSO. The ones that were in the bill—there were no substantial changes, as I recall, in the vehicle efficiency standards.

Senator SMITH. No, I think actually there were. They were left to the Government agency to figure out what those need to be.

Mr. CARUSO. Okay.

Senator SMITH. But did you calculate what those—

Mr. CARUSO. We did not include that because—

Senator SMITH. That picture actually might brighten in terms of conservation.

Mr. CARUSO. That is correct. We did not include that in our analysis because it was left to be determined and therefore we could not put the specific changes in our model.

Senator SMITH. Can you tell me how many LNG terminals are going through the permitting process right now on the west coast?

Mr. CARUSO. On the west coast, there are several. I do not know the exact number. There are about 20 on a nationwide basis, and my recollection is there are several on the west coast.

Senator SMITH. Are they proceeding? Are they having permitting difficulties, or do you know that kind of detail?

Mr. CARUSO. I know that there are five on a national basis that have received either Coast Guard or FERC approval, but none of them are on the west coast.

Senator SMITH. How rapidly do you think Canada's exports to us of natural gas will decline? Quite significantly or?

Mr. CARUSO. We have them gradually declining over the next 2 decades.

Senator SMITH. Mr. Logan, will China turn to nuclear power for its electricity needs? Do you factor that in at all?

Mr. LOGAN. We do anticipate that new nuclear power plants will be built in China, but we also note that Chinese policy has gone through up and down stages of predicting heavier reliance on nuclear power. And then as the market either becomes over-supplied or then under-supplied, the forecasts will dramatically change, and it will depend on who in the back room is making the decisions at the time.

Senator SMITH. Is the Three Gorges dam just about fully operational? And what does that portend for China's energy?

Mr. LOGAN. The Three Gorges dam, when fully completed, will have about 18 gigawatts of generating capacity. Of that, roughly 60 percent is now complete. In 2009, the scheduled completion date, when it is fully operating, that 18 gigawatts will only account for about maybe 2 or 3 percent of the country's total installed capacity.

Senator SMITH. And will it be sufficient to get rid of all of their backup petroleum generators?

Mr. LOGAN. No.

Senator SMITH. Mr. Slaughter, U.S. refineries are operating at full capacity. Will oil companies be forced to import refined petroleum products in the U.S. future, and are ports prepared to accept these refined products?

Mr. SLAUGHTER. If U.S. demand continues to grow along the projections we have seen and new refinery capacity is not added, then the market has to be balanced with imports. What you do see, though, on a year-on-year basis is more efficient operations in existing refineries as maintenance schedules are carried out, which actually give some small percentage of incremental capacity each year, maybe a half a percent of incremental capacity, without building new facilities. But if market demand increases at a higher rate than that, then we are exposed to international trade in products. Yes.

Senator SMITH. Thank you all for your testimony. It has been very informative and I am glad I was here this morning, Mr. Chairman. Thank you.

The CHAIRMAN. Senator Bunning.

Senator BUNNING. Thank you, Mr. Chairman.

Mr. Caruso, EIA forecasts that by the year 2025, two-thirds of all coal production will originate from the Western States. Why do you believe this is the case? Why cannot the Eastern coal companies and Eastern States—what do they have to do stay competitive?

Mr. CARUSO. Well, I think that is exactly the answer; your statement is accurate. The main reason is the west coast is less costly.

Senator BUNNING. Even with the shipping costs?

Mr. CARUSO. Yes, sir. It is more competitive to the point of its consumption even with the transportation costs and, of course, it has a lower sulfur content. Those are the two main factors. So we see east of the Mississippi coal production staying relatively flat over the next 2 decades with most of the growth, which will be considerable given the outlook for electricity generation, to come from the West.

Senator BUNNING. Even with the clean coal burning technologies that were in the energy bill that almost got through the Senate last time? It did not quite make it but it almost did. Even with those incentives for cleanup of Eastern coal, do you still see that same project?

Mr. CARUSO. The forecast does not include the bill provision, since it was not enacted. But my recollection is that even analyzing that component of the bill, it did not make a large change in that, but I would certainly be able to supply you that for the record.

Senator BUNNING. There was about \$4.5 billion worth of incentives to clean up with new technology coal that would burn cleaner and more efficiently, and that included coal from east of the Mississippi, as well as coal from west of the Mississippi. So you do not think that that would make a difference.

Mr. CARUSO. I would prefer to provide that for the record because my recollection of our analysis—we did an analysis of those components of the conference energy bill that we could model that had enough specificity and funding requirements outlined that could be analyzed in our model. So I would be happy to supply that for the record, Senator Bunning.*

Senator BUNNING. In light of recent developments in Russia and the virtual nationalization of the Yukos Oil Company facilities and assets, what actions should we take in the Congress to ensure that our companies can be competitive with foreign companies in developing oil and natural gas infrastructure and resources? Anybody.

Mr. VERRASTRO. Senator, I think in the case of Russia and Yukos, it would probably be helpful if at every opportunity, using diplomatic as well as commercial pressure, that we talk about incentivizing and market reform and proceeding with market reform.

Senator BUNNING. For them?

Mr. VERRASTRO. For Russia, for Venezuela, for a lot of other places. If national oil companies control the vast majority of the resources, increasingly international companies are going to have a difficult time with access. To the extent that state players decide now that you are going to use energy as a strategic commodity and things that you cannot do economically you will do in a bilateral fashion, a diplomatic fashion, to put pressure on other countries and form new alliances—one of the concerns we have with China, for example, is that get 5 percent of their supply from Sudan and 15 percent from Iran.

Senator BUNNING. I understand that but the problem is OPEC and their ability to ignore or deal with nationally held oil resources.

*See Appendix I.

Mr. VERRASTRO. I think it is because they view those oil resources and energy commodities now as so strategic that it is part of the patrimony of the country. This map is changing.

Senator BUNNING. Would it make more sense to the United States of America to develop their own natural resources that are available and not being used now?

Mr. VERRASTRO. I think the two most important things the United States can do in terms of policy is to develop our natural resources that we have, as well as do something on demand management, and reduce our reliance that way. That is actually the more effective response in the short term because the lead time to develop new resources takes time.

Senator BUNNING. Are we going to have a second round, Mr. Chairman?

The CHAIRMAN. Indeed, we will if you are here.

Senator BUNNING. Thank you. My time is up.

The CHAIRMAN. I am going to go to Senator Dorgan on this side.

Senator DORGAN. Mr. Chairman, thank you very much. I will be brief.

I was testifying before a commission this morning and missed the testimony of this panel, but I have read much of it and think that you have added a great deal to the discussion.

I want to ask just a question about hydrogen fuel cells. The chairman and I and President Bush and many others feel that a hydrogen fuel cell future is something that we ought to aspire to create. About every quarter century or so, based on my reading, people with blue suits come and sit at this committee table and people with blue suits come and testify, and we essentially talk about how important it is for us to continue to dig and drill. And while I think we have to dig and drill, I think that is a yesterday-forever policy. I really believe that the only way we are going to find a way out of this is to move toward a different future. Now, that is complicated and not easy to do.

But, Mr. Slaughter, your company with some fanfare opened a hydrogen service station or a service station distribution of hydrogen in this town. I thought it was a nice thing for you to do. I am sure part of it was publicity, but part of it was also a practical first baby step in a direction that I am fully supportive of. Tell us about your experience there.

Mr. SLAUGHTER. Well, it is not quite a first step. We are already quite a long way down the road of thinking about a hydrogen future. We instituted a hydrogen business, Shell Hydrogen, several years ago because we believe in developing technologies for the long term, as I mentioned in respect to coal gasification, increasing the options available for markets to develop. So we see hydrogen as very much a viable energy source for the long term. When we think about the energy systems futures, we are thinking about a 50-60 year time horizon. It will be many years before it matures into something which has a very important role in an energy system.

But to get there, to get hydrogen into a significant place in the market in 30 years, we need to be thinking about these initiatives now, maturing the technology, thinking about the most efficient way of distribution, thinking about the most efficient way of

sourcing the hydrogen. And we are actually spending quite a lot of money on that and developing it.

It is not just important for the United States. It is important also for these developing economies, China, India. Open up the options and they will become less dependent on one particular energy source.

Senator DORGAN. Well, I think the marketplace, including participants like Shell, are moving and doing things. I also agree that there needs to be some public policy initiatives because the kind of movement to this is so expansive and requires so many different issues, production of hydrogen, distribution, storage, and so on. Would you agree that there needs to be public policy initiatives in order to aspire to get to a certain point?

Mr. SLAUGHTER. I believe the public sector and the private sector can very effectively work together in creating a level playing field for these new technologies. Part of it is not so much legislative policy but purely educating the public and the consuming market that the more choice there is, the better it is for consumers. I think that part of the process needs to be emphasized.

Senator DORGAN. You know, there is the old saying: wherever you find yourself, there you are. If we do not set some way-points out there and some objectives to say, by 2050, here is what we would like to see, we are not going to get there.

It is interesting to me that, for example, last night the President talked about Social Security, and we gnash our teeth about what is going to happen in 2042 or 2052, depending on the actuaries or CBO. You know, I asked the Energy Department, I guess, about 4 years ago. I said, what kind of plans do you have for energy, particularly production in 50 years? The answer, we really have not thought out that far. Well, we really should. If we are talking about Social Security in 50 years, let us think about what kind of an energy mix, what kind of an energy future do we want as a country in 50 years because that is a critically important issue.

Let me make one final point to you. We have the Nation's only coal gasification plant on the prairies of North Dakota. It was built, thanks to Federal support, and then changed hands a couple times. It is a technological marvel. It is extraordinary. It is producing beyond anyone's expectation. We now have a relationship with the Federal Government in which we share profits with the owner, the regional cooperative that owns this plant, but we produce synthetic natural gas from lignite coal. Interestingly enough, from the Nation's only coal gasification plant, as we produce synthetic natural gas, we are also piping CO₂ to Canada to put into tertiary wells in oil wells in Canada, which is sequestration. I mean, what a wonderful thing.

The reason I mention that is you talked about coal gasification. We all ought to take a look at the only plant that exists and what a marvel it is and how we are producing this synthetic gas from lignite coal.

Mr. SLAUGHTER. I think that is a great example. The difficulty right now you have in generalizing using the CO₂ for injection for recovery is that often the markets in which you want to put the power plant are not the geographical places where you can use the

CO₂ for exploration and production activities. That limits that option. But we should be looking at others.

The other point I would make about coal gasification is that right now it needs some momentum. Right now, until you have sufficient scale in the pilot plants, the demonstrations at a commercial level, you cannot get commercial financing for them. So it is risk capital for the investors.

Senator DORGAN. The chairman made the point that that came from a public policy initiative, the synthetic fuels initiative, and I think the result was only one plant was built. And frankly, in the early stages, we had some problems with it because the cost of the investment was higher than the market clearing price for natural gas. But that has all changed at the moment.

Well, Mr. Chairman, thank you for recognizing me and thank you all very much for your participation today. It was very helpful.

The CHAIRMAN. I was just going to say the Synthetic Fuels Corporation built that and spent a lot of money. It was the tar baby for those who did not think the Government ought to get involved in advanced projects. We are coming around to wondering how we are going to get some of those kind of way-out technologies, and that ought to be a question that comes along soon here.

Senator Alexander.

Senator ALEXANDER. Thank you, Mr. Chairman.

First, I think Senator Dorgan's comments suggest to me that there is a great deal of consensus in our committee on major objectives toward long-term energy needs. One is the hydrogen fuel cell, and we are going to work on that. It seems to me that the private sector may be moving a good deal faster than a 30-year horizon. I was at a fuel cell filling station in Yokohama where nine major automobile companies each have their own vehicle, and I put hydrogen in the Nissan prototype. And Carlos Ghosn, the CEO of Nissan, drives it around Tokyo every weekend. Nissan is putting \$700 million a year of its own money into hydrogen fuel cells. The Toyota chief executive told me they have a horizon a good deal shorter than 30 or even 20 years for having cars on the road. So that is a promising technology.

But that leads me to the second area of growing consensus here, which is about what can we in the Government most appropriately do about coal. The staff has pointed out to me that the China state environmental protection administration recently ordered 26 coal-fired power plants halted, an estimated 120 megawatts, because developers did not complete the required environmental impact assessments. Now, when we think about the fact that China might be generating 650 gigawatts of coal-based energy in the next 25 years, that is 650,000 1,000-megawatt plants, roughly. We mentioned earlier—Senator Bingaman brought it up—maybe India is another 800. It is obvious it will not matter much what we do in the United States about capturing carbon or global warming if that level of coal production is going on around the world without appropriate environmental restrictions.

So it seems to me that one thing we can do in the United States for ourselves and the rest of the world is accelerate any way we can think of to explore whether it is commercially viable to gasify coal and sequester carbon.

Now, we may get to a hydrogen fuel cell economy, but we are going to have to make the hydrogen somehow. That means it is either natural gas, coal, or oil to make the hydrogen.

The CHAIRMAN. Or nuclear.

Senator ALEXANDER. Or nuclear, yes. Excuse me. That is exactly right.

So what can you suggest to us that we could appropriately do here with making minimum interference in the marketplace, which we do not want to do, that would accelerate our understanding and the market's movement toward coal gasification and carbon sequestration as a way of energy independence and as a way of solving the problem of too much carbon in the air?

Mr. Slaughter, help us out here, and any of the rest of you who can comment on that. What would you do if you were in our shoes?

Mr. SLAUGHTER. Well, I think one of the most important things you can do immediately is create a long-term energy vision for the country, which includes these new options and say as a Nation we need to have a wider mix. We need to develop new technologies. We need to develop cleaner burning fuels. Coal gasification is one of those options. And we need to think beyond the 20- or 30-year—

Senator ALEXANDER. But now we have gotten that far. But in terms of those options, do we just sit back and wait for it to happen, or are there ways that we can encourage that?

Mr. SLAUGHTER. I think having that public debate will be a strong stimulus for the private sector to look at it very seriously perhaps on a bigger scale than it is doing right now.

Senator ALEXANDER. Well you mentioned, or someone did, that the market itself was slow to react to such big changes. It needed to be receptive. Even if the cost of coal gasification was at a competitive rate and carbon sequestration were reliably invented at this point, we still have got a great, big market out there that is slow to react. Specifically what can we do to encourage the market to be open to this specific set of ideas about coal?

Mr. VERRASTRO. Senator, I think there are two things initially that we ought to be looking at. One is to engage in this public debate because if we are actually looking at energy transformation, it takes public policy to set that in place. And then the second piece is to stimulate through incentives for technology development and also for demonstration projects to show that these new technologies actually work.

Senator ALEXANDER. May I ask one more question, Mr. Chairman?

The CHAIRMAN. Sure, absolutely.

Senator ALEXANDER. Do I understand that a demonstration project, a pilot plant is an appropriate next step? And if so, how big a plant? And if so, how many? And what sort of support would it require for major companies to make the investment they would need to make in a coal gasification plant or in technology that would lead us toward effective carbon sequestration?

Mr. SLAUGHTER. It is difficult for me to respond on behalf of Shell because we are not very big in the power generation business. I think—it is very difficult for me to respond to that. We can get back to you on that.

Senator ALEXANDER. I would be grateful for any written suggestions that any of the four of you would have to us on that subject. There are a number of Senators on this committee who are very interested in the subject and we are looking for an innovative, prudent way to understand what we should do.

The CHAIRMAN. Senator, let me say you are absolutely correct in everything you said about the enthusiasm and interest. While they have some knowledge, we are going to go beyond that, as you know, and we are going to have a forum on coal, and it will include this issue. Hopefully we will be prudent enough to invite some people who are in the business of generating who will talk about will the private sector do this if we just sit back and talk about it, or could we do something to push it. We certainly are going to do that.

Senator ALEXANDER. Thank you.

The CHAIRMAN. Senator Murkowski. Thank you for coming, Senator. I know you have a lot of other commitments, and we are glad to have you.

Senator MURKOWSKI. Thank you, Mr. Chairman. I was presiding this morning and I was unable to get out of that. I would rather have been here.

It was interesting, though, because we were talking about Social Security on the floor, but I come in here and, again, it is the energy security that I am convinced we need to be talking about just as much as we are talking about Social Security. So I appreciate, Mr. Chairman, your leadership on this.

I wish that I had had an opportunity to listen to you, gentlemen. I have quickly gone through some of your written testimony, and so if my questions are a bit haphazard, I apologize. If I do not ask the right person, please do not hesitate to jump in.

I guess this would be initially directed to you, Mr. Caruso. In the natural gas assumptions where you referenced the growth in U.S. natural gas supplies dependent on specific items and you also mention production from natural gas in Alaska and anticipate gas coming on line by 2016, how do your figures change? How does your analysis change for the need for imported LNG if our time line on that slips? And I do not want to send out any negative signals here, but we recognize that this is a massive project. We are working very earnestly up in the State right now to get this thing moving, but the reality is it is a very complex project. What happens if that date slips?

Mr. CARUSO. Well, as things stand right now in our modeling efforts, any slippage in domestic supply—and that would, of course, be the case of Alaska natural gas—virtually all of that would need to be supplied by new LNG. And that is why we have LNG going from .4 tcf in 2003 to 6.4. So if, indeed, there was slippage, I am sure that would mean more LNG requirement.

Senator MURKOWSKI. When you looked at the Alaska natural gas picture, was there any taking into account the opportunity for the gas hydrates? We had a presentation just last week before the committee and we had the director of the Oil and Gas Division from the State of Alaska come and give some pretty remarkable statistics about the vast potential for gas hydrates in the State, some 520 tcf on land directly underneath where we are already drilling

and we could just tap right in, and then the incredible potential offshore. Do you look at those unconventional natural gas estimates in your calculations?

Mr. CARUSO. Yes. We share the optimism that ultimately gas hydrates can be a large supplier of natural gas. Our view is that given the technology development and the current knowledge, it is beyond the 2025 time horizon of our outlook. So I would share we share the resource optimism but we are still, I guess you could call it, technology pessimists with respect to deliverability of those gas hydrates.

Senator MURKOWSKI. So you do not assume those reserves in your calculations for available domestic supply.

Mr. CARUSO. There are no gas hydrates in the 2025 outlook.

Senator MURKOWSKI. We want to talk to you next year and see that in there. We want to move forward on it.

Looking at the U.S. energy prices and where you see the price of oil in 2010 and then down the road, obviously a better scenario for a State like mine that derives revenue from oil, tough on the economy. But in terms of making folks like Shell and other producers more interested in exploration, does this up the amount of what we would consider economically recoverable oil, and does that then factor into your calculations for the availability of domestic reserves?

Mr. CARUSO. Yes. There is clearly a relationship between the price assumptions and the reserve development. We do have in our reference case prices coming down, as you pointed out, by 2010, but we have also looked at about four other cases, including prices staying about where they are now in real terms, which would be a substantial change. And we feel that at those higher prices, there would be substantially more incentive to drill not only in this country but in other countries as well. So it does make a big difference. And there are also changes. The technology for what we call unconventional liquids would bring on a lot more unconventional liquids as well. And those scenarios will be available next week.

Senator MURKOWSKI. I cannot let you go without mentioning ANWR. If ANWR and the potential for oil reserves, discoverable, economically recoverable, which under your scenario we feel really ups the ante in terms of what will be available coming out of ANWR, is that included anywhere in your calculations?

Mr. CARUSO. No, because the outlook is based on current rules, regulations, and policies. ANWR is not included, but we have done a number of cases or service reports for, among others, Senator Frank Murkowski, and last year for Congressman Pombo, which indicate that if the ANWR were to be opened for development, within a 7-to-12-year timeframe, the median USGS resource estimate is that it could be producing at its peak rate of about 800,000 to 900,000 barrels a day. At the high end, the USGS resource assessment could be as much as 1.6 million barrels a day.

The CHAIRMAN. What percent is that?

Mr. CARUSO. Well, right now crude oil production in this country is about 5.5 million barrels a day. So as a share of U.S. production, it would be substantial. And as you know, Alaskan production right now is about 1 million barrels a day.

Senator MURKOWSKI. Now, you have indicated that you ran those numbers last year or a couple years ago. How do those numbers change as we are looking at higher prices of oil and recognizing what is now economically recoverable is increased?

Mr. CARUSO. As you stated, those numbers were based on prices that existed 2 years ago in the analysis done for Senator Frank Murkowski and last year for Congressman Pombo. So I think they would be roughly the same because they were already economic. The biggest issue is the pace of development, and that includes permitting as well as other planning.

So the price itself probably would not change those numbers much, but it is possible that you would get slightly increased recoverability at a higher price and that would extend the production profile. But I think the peak numbers—and I am just going from memory now—would be about the same, but I would certainly be willing to look into that and report back to you.

Senator MURKOWSKI. I would appreciate an update as to where we are now based on the numbers, based on the anticipated price per barrel. If you could supply that to us, I would appreciate it.

Mr. CARUSO. I would be happy to do that.*

Senator MURKOWSKI. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Caruso, just as a factoid, would you once again, if you have it in your head—if not, put it in the record—at its peak what percent of American production would ANWR be if all the laws were passed and it was at the peak that you just described? What percent might that be of American production?

Mr. CARUSO. I would be happy to supply that for the record, sir.*

The CHAIRMAN. It is a rather substantial portion.

Mr. CARUSO. Yes, because we anticipate American production to be relatively flat on average over the next 20 years, so that clearly an additional 800,000 to 1 million barrels a day would make a substantial difference.

The CHAIRMAN. So for those who say it is not very much, we might ask what percent does Texas produce? Do you know?

Mr. CARUSO. Well, I think Texas now is under 1 million barrels a day.

The CHAIRMAN. So if it is not very much, we could say, well, we do not need Texas production either. Right?

[Laughter.]

The CHAIRMAN. Anyway, I look at it that way.

With reference to renewables, there is an enormous desire to produce energy that is clean and does not affect global warming, and so we are constantly asked let us maximize renewables so we can solve our problem. Could I make sure we understand?

Renewables in the United States already has a big component which some choose not to call that, but it is hydro. And I do not think anybody assumes we are going to add any significant hydro generation on that renewable side. So when you say renewables over the next 25 years will be 2 percent—that is what you said—because 2 and 7 is 9, and 7 is hydro; the total is 9—does that assume we have put in the incentives for renewables that exist now, or do you assume they are not going to be there?

*See Appendix I.

Mr. CARUSO. We include all the incentives that are in place now. Of course, the production tax credit does expire on December 31st of this year.

The CHAIRMAN. So your current assumptions would include that it expires.

Mr. CARUSO. Yes, sir.

The CHAIRMAN. Could you quickly for the record tell us what it would be if we continue it indefinitely? So we would answer the question for everybody, okay, we have continued that, now here is what our experts tell us. It would be 2.4 percent or whatever it is.

Mr. CARUSO. It would increase, certainly, and I do not have that number off the top of my head. I would be happy provide it for the record.*

The CHAIRMAN. Can you do that? I think that would be good to have. Would you specifically tell us what is renewables under that definition? Because whatever we say, somebody is going to say you did not put everything in. So if you do not put everything in, we are going to ask you to put everything in.

Mr. CARUSO. I will and I can tell you just off the top of my head that the largest components are biomass, wind, and geothermal.

The CHAIRMAN. With reference to China, we now know that China plans to add two new nuclear power plants a year—that is their indication—for the next 16 years. So current plans would be 32. I assume they are 1,000 megawatts. Is that what you all would think?

Mr. LOGAN. Yes.

The CHAIRMAN. Now, that is not a big part of China's needs is it?

Mr. LOGAN. If indeed China added 2 gigawatts of new nuclear capacity each year for 16 years, it would be approximately, at that time, 4 percent of their generating capacity.

The CHAIRMAN. Is that big? Is that a big component, something important?

Mr. LOGAN. Currently it is about 1.6 percent in China. It is not very big, no.

The CHAIRMAN. So the point is that we all go back to the fact that it is either going to be oil, natural gas, or the big one, or some form of coal that is going to be used for generation, even for China.

Mr. LOGAN. Well, China also has ambitious plans to develop their remaining hydropower resources that are there, but yes, you are right.

The CHAIRMAN. Well, you told us about it and I just assumed that even with that giant one they are adding, it is much like nuclear. It is not going to be that big even when finished.

Mr. LOGAN. There are many others also under development that are smaller than the Three Gorges dam but are substantially large. So it will pay a role, but it will not—

The CHAIRMAN. For the record, would you tell us about those? Even though they are just planned, would you put it in a statement for the record, what they are and what their capacity might be?

Mr. LOGAN. Sure.

*See Appendix I.

The CHAIRMAN. I wanted to ask a question with reference to OPEC. This is for Mr. Slaughter and Mr. Verrastro. You discussed a reluctance or inability of OPEC to expand its oil production capacity. Do you think OPEC purposely created inventory tightness in 2001 and 2002 and is now working to deprive the market of the ability to build inventory?

Mr. SLAUGHTER. I think OPEC relies on a team of analysts and forecasters like many organizations to predict what is happening in oil markets. I think pretty much across the board most organizations under-estimated global demand growth, not just in 2001 and 2002 but right through until last year. So I think there was a certain element of surprise in the strength of global demand over the last few years for OPEC and for the consuming countries. So I do not agree that it was a conspiracy to drive inventory levels down.

OPEC has a dilemma in terms of the pace and the extent to which it adds production capacity because many of the producing countries do not have very diversified economies. So investment capital they put into oil-productive capacity is investment capital that does not go into diversifying the economy to reduce their dependence on oil. So it is a real dilemma. They also have pressing social needs in terms of their growing and youthful populations. So I believe that balancing all that is very difficult and perfect knowledge is not available to OPEC as it is not available to us.

Mr. VERRASTRO. I think I would echo Andrew's sentiments on that. If you go back and look at the second quarter of last year, the IEA projected total demand to be about 77.5 million barrels a day. They made eight revisions in 8 months, and it turned out to be over 81 million.

OPEC, like everyone else, looks back at their history in deciding future policy, and coming out of the late 1990's, they had excessive spare capacity, so much so that they had to cut production in certain areas.

If you look at the price—and this is the other piece of it—what these revenue needs are for these individual countries over the last 25 years, their total export revenues have gone from about \$30 billion to \$300 billion. So for planning purposes, it has been a very difficult planning period.

I was with a minister last February after the OPEC meeting and his sense was exactly what Andrew said, that coming out of the OPEC meeting, they were looking at second quarter demand crashing. No one knew what China was going to do. They were concerned about Iraq coming on, the prospect of Libya coming on in the future, and Russian production being healthy, and the call on OPEC looked to be a lot less. And those forecasts were obviously wrong.

The CHAIRMAN. My last observation, and then if Senator Alexander would not mind, if he has time, if he could finish the hearing with the last two Senators, I would appreciate that very much.

I want to say for the record and to the four of you—and if you have an observation, that would be fine—I think we understand how the diversification ought to occur over the next 10 or 15 years to create a bit more security for us. Obviously, we have got to find a way to use coal and still not have a terrific impact on global

warming. Others may not care about the latter, but we are going to have to.

The dilemma we have is that we believe in a free market and capitalism, and yet, when it comes to projects that are way out that involve a lot of capital, it is not very easy for the private sector to do that. First of all, it is not very good business for the bottom line so as to speak, and stockholders are not very interested in it. If you say we are going to issue some bonds and put out \$1.5 billion to do two pilot projects in coal gasification, including reduction of carbon, how are they going to do that?

One of the problems is do we have any business, any reason as a Congress to do something about that or do we sit by and wait and say at some point in time, it really will come on when we are really hurting. To me it seems like that is way too late because it seems we will be in an international crisis, the likes of which we do not even understand, at that time.

Could you just talk about this? Particularly you, Mr. Slaughter, you would know from the business standpoint. You all are very big and the rest of you have some feeling. Is my assessment sort of right, or will those things just happen even if we do not do anything about it?

Mr. SLAUGHTER. Well, there is capacity in the private sector to invest for the very long term, in the major companies, the international oil companies like Shell. I had mentioned several of the things we are doing for the very long term in terms of hydrogen and renewables and technology on coal gasification. So there is the capacity to invest.

Basically it involves putting in seed capital at a fairly low level and then maturing the technology over a number of years until the market is ready, but we do need a stable market environment and a receptive consuming public. That involves making the country very conscious of the energy choices and the energy futures that are available and open to it. So I believe a public education process in this is very important.

The second point I would make is that energy markets, by their very nature, are global. Not only are they global in terms of traded goods, but they are global in terms of technology development. So we are going to go ahead in maturing these technologies. And maybe it will not happen in the United States. Maybe it will happen in other markets. But when a technology is developed, it is available for all markets typically and will migrate to where it has the most value. So it is not something the U.S. has to take on on a unilateral basis.

The CHAIRMAN. Does anybody else have a thought?

Mr. VERRASTRO. Again, I would echo Andrew's comments. I think there are two things that you pointed out, Senator, that are extremely relevant. One is the difference between public policy and private sector investment cycles. I was a senior vice president at Pennzoil for about 17 years, and when you look at things as they come across the board in the management committee, you look at the cost to shareholders and you look at your rate of return and you look at expending capital versus other prospects that you have. So it is extremely difficult for companies. Even in the current envi-

ronment, there is the expectation that with high prices a lot more drilling, a lot more exploration will go on.

But, in fact, what you would probably look to do is if you cannot find a good commercial deal around the world because a lot of these host countries you cannot have access, or you are in the situation where you cannot negotiate good commercial terms because the commodity is so attractive to these countries, that you tend to stand back a little bit and watch and wait what happens. As a result, in terms of quarter-to-quarter projections, your expenditures go down. Your income rises just as a result of current production with higher prices, and you look good on Wall Street. Your shareholders are very pleased. But you have to take a longer-term perspective.

I was also fortunate enough, I think, to be part of the Carter administration in the first energy plan and we developed the Syn Fuels Corporation. And it did get lambasted and prices dropped in 1981 and people walked away from it because at \$10 or \$15 a barrel, it made no sense to develop 15 years out a backstop technology that was \$40 or \$50. But I do think it takes both the private and the public sector in combination to push this thing forward.

The CHAIRMAN. Thank you very much.

Senator Alexander, you are in charge.

Senator ALEXANDER [presiding]. Senator Bunning.

Senator BUNNING. Thank you.

I want to get a handle on additives and how much we can rely on their ability to help our supply. We have the ability in the United States on ethanol, biodiesel, and other things to add what percentage to the overall supply of what we are using now mainly for our gasoline and other things and to drive our trucks and to drive our cars? How much of that can be added or increased to keep the price of those and the purity or the better conditions for the United States into the immediate future?

Mr. CARUSO. We did look at, when the bill was being debated last year, the ethanol requirement of 5 billion gallons by, I think, 2012 or so and looked at what that would imply, as well as we also have done some work in terms of biodiesel. It is still relatively small. It is a big number, but when we are talking about a gasoline consumption that is headed toward well over 10 million barrels a day in our outlook—

Senator BUNNING. In other words, the capacity to produce is the problem?

Mr. CARUSO. It is the capacity to produce, plus it is the economics under existing laws and regulations. It is both.

Senator BUNNING. So if, in fact, we change the existing laws and regulations—that is something that we can do—it might assist in the production of more ethanol, more biodiesel fuel, which in my opinion is a viable alternative to what we have if we are not going to use our natural resources that we have available in ANWR and other places.

Mr. CARUSO. That is correct.

Senator BUNNING. So we can look forward in our energy bill, Senators, to incentivize those things a little better than we did the last time so that there is a larger production.

I want to thank you all because our energy policy in the United States of America has been on hold for so long that we are ground to a halt in trying to make it better. Now, when you get within two votes of a major energy bill and incentives to make it better, whether it be liquified coal or hydrogen or new sources of energy, and incentivizing the use of coal for different purposes other than just the production of electricity and those things, we need help, and we need to be able to sell this to the American people as something that is absolutely necessary if we are going to survive as a Nation. No matter how hard we try to move that number from 55 to 58 to 60 to 65, dependency on foreign resources is unacceptable. It is totally and completely unacceptable for our national defense, for our national security. So please help us. We need your help. Thank you.

Senator ALEXANDER. Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman.

I want to talk just real quickly about two of Alaska's neighbors, Canada and Russia. A very quick question on Canada, and this is probably to you again, Mr. Caruso. I came in at the end where you were talking about Canadian exports of natural gas and your assumption that there would really not be much coming to the United States from Canada because of their consumption. I am assuming you factor in the gas coming down from Mackenzie and that line.

Mr. CARUSO. Yes.

Senator MURKOWSKI. But it is your assessment that the Canadians will use what they currently have in addition to the new source coming out of Mackenzie.

Mr. CARUSO. That is correct. We made our latest forecast taking into account the National Energy Board of Canada's forecast for Canadian production as well as consumption and, of course, bringing on stream the Mackenzie Delta valley gas toward the latter part of this decade, I think 2009, 2010. We have it in our outlook. But even with that, we have less gas coming from Canada over this outlook period over the next 20 years.

Senator MURKOWSKI. So you do not view the two projects, the Mackenzie line and the Alaska natural gas line, as competing projects.

Mr. CARUSO. Definitely not. They will both be needed.

Senator MURKOWSKI. Absolutely. Thank you.

And then a question about Russia. Just reading through the background, recognizing that Russia is currently the second largest exporter, how much do we import from Russia?

Mr. CARUSO. Not very much.

Senator MURKOWSKI. So it is negligible.

Mr. CARUSO. 100,000 barrels a day or so out of our more than about 11 million.

Senator MURKOWSKI. I was reading, Mr. Verrastro, your comments about the future for Russia and a very tentative assessment of where you think they are going. You state that the developments raise the prospect that they may be nearing a temporary peak because of a multitude of reasons that you cite. You also indicate that the inability to continue to increase production rests on several

considerations. Production practices are suspect. What do you mean by that statement?

Mr. VERRASTRO. I think two things. The resource base. Most people believe that Russia has substantial resources. The question is whether they have been producing for rate or actually exploring new territories that they can produce for over the long term. There is concern that Yukos, in particular, over the last several years, while they were very successful in moving oil to market and increasing production, that it was what we call step-out drilling. It was the easy oil to get to, least expensive, and you are actually depleting the reservoirs faster. There has not been new exploration. And the infrastructure, quite honestly, is also suspect in terms of pipelines and delivery systems.

Senator MURKOWSKI. It is old or when you say it is suspect?

Mr. CARUSO. Yes. When we were in the Caspian, the rated capacity of some of the Russian lines that were at 200,000 barrels a day, if you put 200,000 barrels a day through them, they would burst at the seams. So part of the reason that they were running at about 50 percent capacity was just because they were concerned about infrastructure breakdown.

Senator MURKOWSKI. Where do you see them going then? You recognize they have got the resources. They are somewhat like Alaska. We have definitely got the resources. With us it is absolutely access, and to a certain extent, the Russians are in the same situation. But how do you see them moving forward?

Mr. CARUSO. I think the three restrictions are in terms of infrastructure, policy, and investment, and also the introduction of new technologies. Where they go from here, some people are projecting 10 million to 12 million barrels a day, in terms of increased production. Others are looking at a plateau and then a decline if new investment is not brought in soon. I think the Yukos episode kind of froze people in place, at least for a time, just to see what policies would be emanating from the Kremlin. Prior to that, Russia looked like a great place to go explore and invest, but increasingly—and you saw it with Conoco-Phillips that the way to do business in Russia, at least at this particular time, is to go to the Kremlin first, get the approval from the president, and then go do your side deals to do investment or equity participation in projects or with other companies in Russia. Right now it is probably not the way to go.

Senator MURKOWSKI. You used the term “it needs to happen soon,” and I am assuming because of all the reasons that you have cited, whether it is the infrastructure or the policies. But we recognize that when you build a pipeline of any size, it is going to take some time to bring on. It seems that there is a lot of expectation or hope coming out of Russia that they are going to be able to keep the levels of production that they have, that they will continue to be the second largest oil exporter. But your assessment is, as I say, somewhat hesitant here. Do you think that they can maintain that status?

Mr. VERRASTRO. I think a lot depends on where the policies go forward. I think President Putin recognizes that oil and gas are the engine that is going to fuel economic growth in Russia. The point is that I think he is looking to centralize control, whether it is in state-owned companies or government mandates. Gazprom and

Transneft control the distribution networks. So even if you produce, you have to find a way to export. The oil is there. It is just a question of how you get it out and move it to market.

Senator MURKOWSKI. I struggle with what we are able to do on the North Slope of Alaska. As I say, we have got the resources up there, but we have got some issues in terms of getting them out. And some of those that would look at extraction up north and production opportunities instead go to our neighbors right across the water. I would like to think that we offer them a little more stability, a little more security in terms of policies and in terms of opportunities. So I am curious to hear your perspective on Russia.

Mr. Slaughter, I would love your comments.

Mr. SLAUGHTER. May I jump in on a couple of things there? I think it is not a question of Russian resources getting developed in competition with Alaskan or Canadian resources. I think over the next 20 or 30 years, the world will need additions from both and be very capable of absorbing all the production that both regions can give.

Russian production will fluctuate year to year as policy changes, as capacity gets built or gets delayed, but over the long term, we are very optimistic the resource base will be developed. We have got some very big investments in Russia. Some of our competing companies do as well, and we have to work with them on a company-to-country basis and on a country-to-country basis to ensure a stable and fair fiscal and regulatory environment over the long term. I think it has to become clear to all the big players in world energy markets that we need that stable environment to develop resources.

Senator MURKOWSKI. Are things getting better as you engage in the dialog with the Russians as it relates to your business investments?

Mr. SLAUGHTER. I am sorry. I did not quite—

Senator MURKOWSKI. Well, is it getting easier to deal with them or is it still complicated?

Mr. SLAUGHTER. We deal with them on a project-by-project basis, based on our particular investment profile. I think it has been challenging at times, but we get things done and it is moving on and we would like to have more of the opportunities.

In terms of the Mackenzie Delta and Alaska gas, I would like to say that the assumptions on those are largely based on current outlooks for production in both areas, both in Alaska and MacKenzie. There are step-out opportunities offshore, for example, which are very interesting, which could actually supplement the Canadian supplies and it could also supplement the Alaskan supplies long term. I think we need to look at those as well as focusing on the existing proved resource.

Senator MURKOWSKI. Absolutely.

I want to thank you all for your time here this morning. I certainly learned a lot and appreciate the information.

Thank you, Mr. Chairman.

Senator ALEXANDER. Thank you, Senator Murkowski.

A lot of the talk this morning has been about new technologies and the solutions to the challenges of energy independence. And the environmental challenges of producing so much new energy de-

pend, to a great deal, on new technologies. There are a number of forecasts that suggest that many of the new technologies might come from somewhere other than the United States, other parts of the world, China, India, Brazil, Korea, Thailand. We see a concern in this country long term about the smaller number of scientists and engineers who are homegrown who are going to our colleges and universities.

So I am wondering if we are looking over the next 10-20 years at the twin challenges of energy independence and a clean environment, should we be cooperating internationally on technologies, or are we already doing that?

I think of the example of fusion, which is an advanced technology far down the road, but we are now cooperating with two or three other countries, Japan and France I believe, in that.

So my question is, are we now cooperating in terms of technology with other countries when it is a matter not so much of us protecting our own intellectual property rights but getting access to others? Can we combine efforts with China, for example, on clean coal technology or with India or with any other country? What is being done now, and would you suggest any policy changes that we ought to consider that would accelerate technological development that would permit more energy independence and a cleaner environment?

Mr. SLAUGHTER. In terms of private sector research and development and technology, yes. That certainly happens internationally and it is done across units in different countries and different markets. I cannot comment so much on the public sector cooperation because I am not so familiar with it, but I think it is positive. Markets are interconnected and it spreads the risk and opens up opportunity if you can cooperate on technology development.

Senator ALEXANDER. Does anyone else have a comment on that?

Mr. LOGAN. From the IEA's perspective, the 26 members of the International Energy Agency do have a number of technology exchange agreements amongst our members, but also with participation from countries like China and India. My general feeling is that it is useful but that much more could be done in venues such as the IEA.

But I also believe that at the bilateral level, the United States could play a much larger role in international cooperation to develop technologies and that it would be extremely useful for our interests, not only commercial interests but also national security and environmental interests as well. For example, if you look at the amount of spending that the U.S. Government contributes to countries like China, for example, on cooperative technology research, it is, I think, much smaller than, for example, what Japan, at least until the recent past, had been spending in China.

Mr. VERRASTRO. Senator, one other point. When we talk about energy independence, I like to think of the world as more energy interdependent. As you travel and you try to deal with issues of reliable energy supply going forward in the future and environmental benignness, it would be good for not only technological exchange and technology transfer—and I think the Department of Energy and the IEA are doing some of that, as well as the private sector.

But I do think intellectual property rights is a hurdle that companies have to get over as well.

Senator ALEXANDER. Well, would you agree that in this case that it may be a matter of us getting access to other countries' intellectual property rights than ours, or is still almost all the new technology coming out of the United States?

Mr. VERRASTRO. No. I think that is true. I think in the case of nuclear, for example, we have not built a new nuclear facility in this country for a long, long time, but other parts of the world have. So we may be falling behind because we have not been able to develop certain technologies and apply them.

Senator ALEXANDER. Might we learn something from the France about the storage of spent fuel rods?

Well, there are a variety of other questions that we could ask, but this has been a very interesting subject. I think you and the audience can tell by the attendance of a large number of Senators on a day when there were a lot of other important events going on in the U.S. Senate.

Senator Domenici has several questions for the record that ask for additional information. Please be assured that if you will take the time to provide that to us, we will pay attention to it.

We thank you very much for your time. The hearing is adjourned.

[Whereupon, at 12:18 p.m., the hearing was adjourned.]

APPENDIXES

APPENDIX I

Responses to Additional Questions

RESPONSES BY GUY CARUSO TO QUESTIONS FROM THE COMMITTEE

Question 1. Provide the Committee with a list of companies exporting crude oil and refined products outside the U.S. and the amounts.

Answer. The Energy Information Administration (EIA) does not collect petroleum export data. EIA's petroleum export statistics are based on aggregate export data obtained from the U.S. Bureau of the Census on a monthly basis. Those data are sufficient to meet the analytical and dissemination needs of EIA. We have been advised by officials at the Census Bureau that, while we could obtain its company-level information under an inter-agency Memorandum of Understanding (MOU), we would not be authorized to release it to a third party. Senator Wyden's office has been apprised of this situation, and we understand that his office has contacted the Census Bureau directly.

Question 2. Analysis of Conference Energy Bill's Clean Coal Incentives. What are impacts of the clean coal incentives in the energy bill.

Answer. In response to a request received from Senator John Sununu on February 2, 2004, EIA performed an assessment of the Conference Energy Bill (CEB) of 2003. The full analysis is available at the following link:

[http://www.eia.doe.gov/oiaf/servicerpt/pceb/pdf/sroiaf\(2004\)02.pdf](http://www.eia.doe.gov/oiaf/servicerpt/pceb/pdf/sroiaf(2004)02.pdf)

This report summarizes the CEB provisions that can be modeled using the National Energy Modeling System (NEMS) and have the potential to affect energy consumption, supply, and prices. The impacts are estimated by comparing the projections based on CEB provisions with the Annual Energy Outlook 2004 (AEO2004) reference case.

There were several provisions in the CEB that provide incentives to develop clean coal technologies. Section 1351 of the CEB provides a 17.5-percent investment tax credit (ITC) for new coal-fired generating units employing advanced clean coal technologies, such as advanced pulverized coal, fluidized bed, or coal integrated gasification combined cycle (IGCC). The tax credit applies to facilities placed in service before January 1, 2017, and is limited to 6 gigawatts. The 6-gigawatt cap is to be divided evenly between advanced IGCC plants and advanced pulverized coal plants. To qualify as an advanced clean coal technology, a plant must meet a minimum technology-specific energy conversion efficiency and carbon dioxide emission rate.

The ITC for advanced IGCC units is expected to increase this capacity by about 22 gigawatts above the Reference Case level. While the ITC is only available to the first 3 gigawatts of IGCC capacity, it causes plants to be built earlier than otherwise expected, making the technology more competitive in later years of the projections. An ITC is also specified for 3 gigawatts of advanced pulverized coal capacity, but more than 3 gigawatts are expected without the ITC, so the CEB does not cause more advanced pulverized coal capacity to be built. Overall, EIA found that the total pulverized coal capacity is actually lower in the CEB case because other provisions in the CEB package affecting natural gas supply, and nuclear and renewable energy, result in lower natural gas prices that make natural gas capacity more economical and also bring on more nuclear and renewable capacity that dampens the additions of new pulverized coal capacity.

Question 3. Peak Alaska crude oil production contribution. What percentage of total U.S. crude oil production does Alaska represent today and would represent in the future with ANWR?

Answer. According to the *Monthly Energy Review*, Alaska represented 16.7 percent of total U.S. crude oil production in 2004. That is projected to decline to 11.0 percent by 2025 without production from the Arctic National Wildlife Refuge (ANWR). Based on a March 2004 service report for Congressman Pombo incorporating ANWR production at the earliest possible date and assuming the mean USGS resource estimate is realized, it was found that Alaska crude oil production would peak in 2019 at 1.524 million barrels per day and represent 25.8 percent of total U.S. production.

Question 4. Peak ANWR crude oil production contribution. What percentage of total U.S. crude oil production would ANWR represent at the peak year?

Answer. Based on a March 2004 service report for Congressman Pombo incorporating ANWR production at the earliest possible date, it was found that, under the assumption that the mean USGS resource estimate is realized, peak incremental Alaska crude oil production would occur in 2024 at 876,000 barrels per day and represent 15.6 percent of total U.S. production. On a percentage basis, peak incremental production occurs in 2025 at 15.9 percent, due to falling lower-48 production.

Question 5. Impact of extending renewable production tax credit. What would be the impact if the renewable production tax credit (PTC) were extended beyond its current expiration date?

Answer. Consistent with current laws and regulations the reference case in the Annual Energy Outlook 2005 (AEO2005) assumes that the production tax credit (PTC) for renewables will expire in December 2005. However, an additional case is included in the AEO2005, which assumes that the PTC is extended for 10 years, through 2015. In both these cases, the PTC is assumed available to wind, biomass, geothermal, and solar facilities.

In the reference case, electric power sector non-hydroelectric renewable capacity is projected to grow from 14 gigawatts in 2003 to 25 gigawatts in 2025. The increase is expected to come from wind, biomass and geothermal, with wind accounting for about half. Approximately 2.4 percent of total electric sector generation is projected to come from non-hydroelectric renewable sources in 2025 in the reference case.

In the PTC extension case, electric power sector non-hydroelectric renewable capacity is projected to grow from 14 gigawatts in 2003 to 78 gigawatts in 2025. New wind plants are projected to benefit most from the PTC extension. Between 2003 and 2025, electric power sector wind generating capacity is projected to grow from 7 gigawatts to 63 gigawatts. In 2025, electric power sector non-hydroelectric renewable sources are projected to account for 5.7 percent of total electric power sector generation, more than double the level expected in the reference case.

A complete discussion of the reference and PTC extension cases is provided in the Issues In Focus section of the AEO2005 at:

<http://www.eia.doe.gov/oiaf/aeo/index.html>

APPENDIX II

Additional Material Submitted for the Record

STATEMENT OF CHEVRONTEXACO CORPORATION

THE NEW ENERGY EQUATION: WISE ENERGY USE AT HOME AND GLOBAL ACCESS, DIVERSIFICATION AND SECURITY

ChevronTexaco thanks the Committee for holding this hearing on global energy trends and their impact on U.S. energy security and policy. We are pleased to share our recommendations for U.S. energy policy in light of these global trends.

ChevronTexaco brings significant experience on global energy issues—we are the fifth largest integrated energy company in the world and second largest in the U.S. We have global oil and gas exploration, production, refining, marketing and transportation activities. Our worldwide crude oil and natural gas production is 2.5 million oil-equivalent barrels per day.

THE NEW ENERGY EQUATION DEMANDS A STRATEGIC, GLOBAL ENERGY POLICY

Energy is quite literally the lifeblood of the U.S. and global economy and a critical determinant of human progress at home and abroad. Today, America and the world face a new equation on the stability of the supply and price of energy. This new equation results from increased and sustained demand particularly from China and India, declining sources of supply from traditional energy sources, and increased geopolitical risk in areas where energy is produced. The result of this new equation so far is tighter and more vulnerable energy supplies, and sustained higher energy prices.

The Federal Reserve recently concluded that higher energy costs are constraining consumer and business spending in the United States. The International Energy Agency has also acknowledged that higher oil prices are dampening global economic growth. America's energy policy can no longer stop at the water's edge. We need to develop a strategic, global energy policy based on two fundamental precepts:

- Aggressive policies at home to reduce consumption, increase energy efficiency and develop alternative supply sources, and
- International engagement to ensure continued access to diverse international energy supplies, particularly as competition for these supplies intensifies.

Trade and investment issues, tax policy, foreign policy, bilateral, regional and multilateral relationships, and U.S. Government international advocacy efforts must be more effectively and strategically integrated with our traditional domestic energy agenda.

CHEVRONTEXACO RECOMMENDATIONS FOR AN ENERGY-INTERDEPENDENT WORLD

There has already been much debate in Congress on the domestic energy policy agenda, and on the domestic front we respectfully ask Congress to enact the energy bill debated in the past two Congresses. However, there needs to be more discussion on international engagement, and will be the focus of the rest of our testimony. *We need to recognize that the United States and the world are energy interdependent.* The U.S. consumes more oil and gas than we produce, and the Energy Information Agency's forecast is that we will continue to do so. ChevronTexaco's energy policy recommendations have specific ideas on how the U.S. government can improve our energy security through constructive international engagement. Included are recommendations for developing a strong investment framework for energy investments around the globe by:

- Opening markets and reducing trade barriers to foster market-driven investment climates for increased energy supplies,

- Protecting energy investments by assisting transitioning economies to develop institutions and systems of good governance and support for the rule of law,
- Improving the business climate for U.S. energy investments overseas through improved international trade rules, and
- Working through multilateral organizations such as the IMF and WTO to help liberalize trade, and develop good policy mixes to sustain responsible economic growth.

(See *Global Energy Security Paper and Global Business Climate Paper for additional details*).

It is time for U.S. business to work with the U.S. government and recognize energy as a strategic—and global—issue. Corporate America can no longer treat energy as merely an expense item, and government can not afford to focus on energy as simply a domestic issue. U.S. energy policy in the 21st century must reflect our interdependence with producing countries, and encourage bilateral relationships that recognize the importance of energy development and promote the flow of investment in energy resources. The end of easy energy may mean the end of easy choices, but recognizing the new energy equation is a strong first step towards working on constructive ways to meet the new challenge.

Attachments:

1. ChevronTexaco's Energy Policy Recommendations
2. Opinion Editorial: The New Energy Equation by Dave O'Reilly, CEO of ChevronTexaco

ENERGY POLICY RECOMMENDATIONS FROM CHEVRONTEXACO

DOMESTIC ENERGY STRATEGY: "IMPROVING U.S. ENERGY CONSERVATION, SUPPLY AND USE"

Energy is the lifeblood of the American economy, affecting the competitiveness of virtually every sector and touching nearly every aspect of American life. Over the past several years, domestic production of energy resources has matured and declined while, at the same time, U.S. and world demand have continued to increase. With these changes has come recognition that energy is a key strategic issue important to U.S. consumers and businesses alike. Providing diverse, reliable and affordable sources of energy is paramount to a national energy policy that will stand the test of time.

ChevronTexaco stands ready to work with the Administration, Congress, policy makers, and other stakeholders to develop a comprehensive U.S. energy strategy for the 21st century. One important aspect is how the U.S. manages energy domestically. ChevronTexaco believes our energy strategy should:

- Ensure *sufficient and diverse energy supplies*
- Encourage *responsible use of energy*
- Enhance *regulatory certainty to improve the investment climate for energy*
- Support *basic and applied scientific research* to improve energy availability and use

ChevronTexaco strongly supported the energy bill (H.R. 6 conference report) in the 108th Congress, and is committed to work towards a comprehensive domestic energy strategy consistent with the above principles.

Ensuring Increasing and Diverse Energy Supplies—With energy demand continuing to rise, the United States will need a diversity of supplies to meet our future energy needs. Specific steps the U.S. government (USG) can take to ensure such diversity include:

- *Promote Increased U.S. Exploration, Production and Refining*—The USG should encourage the responsible development of oil and natural gas resources in the Gulf of Mexico, the Rocky Mountains and elsewhere in the United States. Further, the USG needs to work with local communities to overcome opposition to energy projects and help streamline permitting efforts in order to allow for new and expanded refining capability to meet growing U.S. needs.
- *Diverse Fuel Supplies*—The USG should promote performance standards and not mandate or subsidize specific types of fuels or energy. This will allow all energy sources to compete on a level playing field. ChevronTexaco is ready to work with the USG to reduce "balkanization" resulting from boutique fuels while protecting the environment.

- *Natural Gas*—USG should support construction of a pipeline (without subsidies) to bring additional supplies of gas from Alaska and Canada. It should also help facilitate the efficient growth of liquefied natural gas (LNG) to meet the increased natural gas demand. ChevronTexaco is poised to provide new supplies of LNG to help meet growing energy needs on the U.S. Gulf and West coasts.
- *Electric Power*—The USG should set standards to improve the reliability of electric power, facilitate the development of open and transparent markets, and support the use of efficient electric power generation—e.g. cogeneration.

Responsible Use of Energy—The U.S. government should support continuous improvement in the responsible use of energy to further goals of energy security, environmental performance, conservation, and energy efficiency. Specific steps the USG should take include:

- *Conservation and Energy Efficiency*—In the near-term, conservation is the easiest, most reliable “new” source of energy. The USG, as a large consumer of energy, should lead the way in becoming more energy efficient. The USG should continue to support its Performance Management Contracting program. ChevronTexaco has also reduced its energy use by 22 percent in the past 12 years through conservation and improved energy efficiency. ChevronTexaco has a subsidiary called Chevron Energy Solutions business whose sole function is to help both private and public sector customers save energy in their operations.
- *Gasoline and Diesel Fuel Reformulation*—As federal, state and local governments have adopted new fuel standards to improve environmental performance and reduce emissions, ChevronTexaco has worked with regulators, the auto and oil industry, researchers, and others to reduce sulfur content of fuels, and to help reformulate gasoline and diesel to reduce tailpipe emissions from vehicles. ChevronTexaco will continue working constructively with the USG to see that new fuel requirements are fully implemented.

Enhance Regulatory Certainty—The United States government can improve the investment climate for energy projects by decreasing regulatory uncertainty. Specific steps the USG should take include:

- *Permit Streamlining for Energy Infrastructure*—The USG needs to assist in assuring timely permitting, and working with local communities to overcome obstacles so that necessary LNG re-gasification and distribution facilities can be constructed in a timely fashion. Additionally, with U.S. refineries running at/near capacity, the USG needs to help streamline permitting processes for refinery expansions. More specific recommendations on how to streamline the permitting of energy infrastructure are included in the paper on “Environmental Protection: Responsible Stewardship of the Environment and Energy Resources.”
- *Avoid Rule Changes*—Once federal or state governments establish new requirements (e.g., new fuel standards), those governments should avoid making last-minute changes that create market uncertainty. It can take 3 to 4 years for a refinery to plan and complete plant modifications to meet new requirements. Last-minute waivers that allow noncomplying refiners/marketers to avoid or defer compliance penalize companies that have made good-faith investments to comply with the rules on the books. The EPA needs to develop a variance process, with per-gallon penalties for noncomplying fuels, to maintain a level playing field with those companies who play by the rules and make the necessary investments in a timely manner.

Support for Basic and Applied Research—The USG, in conjunction with other governments and the private sector, has a fundamental role in advancing basic scientific research related to energy. The private sector thrives on partnerships between companies, national laboratories, universities and public agencies to strengthen the nation’s technical capabilities. ChevronTexaco has developed specific recommendations for the USG role in research and development in its paper on “Leveraging Technology—Ensuring Sustainable Energy Supply and Use.”

ENVIRONMENTAL PROTECTION:
“RESPONSIBLE STEWARDSHIP OF THE ENVIRONMENT AND ENERGY RESOURCES”

Protecting the environment is a key value in the ChevronTexaco Way—which describes ChevronTexaco, what we believe, and what we plan to accomplish. We are proud of our reputation and work everyday to improve it. We must. Standards for environmental protection are growing tougher. Society, including our customers, shareholders and the communities in which we do business, expect us to continuously improve.

At the same time, the ChevronTexaco Way encourages us to constructively engage in public policy debates, including those around the environment, in ways that are solutions-oriented and lead to environmental stewardship improvements. We are eager to work with the Administration to develop effective, creative, approaches to progress environmental performance and care.

We believe environmental public policy should:

- Lead to improvement in environmental quality and minimize unintended consequences
- Prioritize environmental problems in order of risk, and solutions in order of cost-effectiveness
- Apply sound science to all phases of decision-making
- Develop requirements in a manner that considers economic growth, allows flexibility for the regulated community to respond to market conditions, and provides regulatory certainty to encourage investments

Climate Change—We recognize and share the concerns that governments and the public have about climate change. In addressing climate change, we support flexible, market-driven and economically sound policies and mechanisms that protect the environment. Our recommendations to the USG are:

- One national program for voluntary greenhouse gas (GHG) reporting—the DOE program 1605(b) currently under revision.
- Increased government support for R&D of advanced technologies to separate, capture and geologically store CO₂. Also, the government needs to continue its international dialogue on carbon sequestration, particularly the Carbon Sequestration Leadership Forum program.
- Encouraging the use of near-term cost-effective voluntary actions to reduce GHG intensity in the U.S. The government should recognize and publicize voluntary industry actions to reduce GHG. In addition, the government should increase its efforts to encourage energy efficiency by consumers and others.

The Kyoto Protocol, the international treaty to reduce greenhouse gases, is expected to shortly be approved by Russia and enter into force. We will work constructively with governments to implement treaty provisions wherever we have operations in countries that are signatories. ChevronTexaco will continue to manage our greenhouse gas emissions by taking 4 types of actions: 1) reducing emissions of greenhouse gases and increasing energy efficiency; 2) investing in research, development and improved technology; 3) pursuing business opportunities for promising technologies; and 4) supporting flexible and economically sound policies and mechanisms to protect the environment.

Permit Streamlining for Energy Projects—Permit streamlining will encourage energy infrastructure, such as refineries, to implement projects that build capacity and/or increase efficiency and reliability. The permitting process should be clear, and simple, with agency roles and responsibilities well defined. One lead agency should be designated with the responsibility for meeting overall permitting deadlines and coordinating with other agencies to eliminate bottlenecks. The process should allow for public input and applicant appeals and ensure date-certain resolutions.

Air

- *New Source Review (NSR)*—Uncertainties surrounding NSR permit requirements can stall important energy projects and environmentally beneficial projects such as cleaner-burning fuels. Refining and producing operations within the oil industry are interrelated, continuous and very complex. A permitting delay or loss of operational flexibility due to NSR could impact our ability to supply our markets. We strongly support streamlining and clarifying these rules to provide regulatory predictability and de-bottlenecking. Issues of most importance include interpretations of “routine repair and maintenance” and other permitting triggers.
- *National Ambient Air Quality Standards (NAAQS)*—The EPA recently announced areas in the U.S. which are in non-attainment for ozone and particulates. We urge EPA, particularly for ozone attainment plans, to recognize that the timeline for benefits of control measures already on the books (e.g. low sulfur gasoline and diesel) will not be fully realized until well after the attainment deadlines for state implementation plans. The administration needs to consider ways to recognize the benefits from full implementation of these new control measures to avoid unintended consequences—such as another generation of boutique fuels that can lead to supply disruptions.

Remediation and Water

- *Natural Resource Damages*—We support NRD reforms that focus on remediation of ecological services using generally accepted scientific and economic methods. Unfortunately, some trustees view natural resources damages as a means to generate funds to offset budget shortfalls and generate private attorney fees. Program reforms should focus priorities on natural resources by limiting the potential for highly inflated damage claims, reducing incentives to use these claims to offset budget shortfalls and speeding remediation of resources for the public.
- *Cleanup Program Reform*—We support ways to safely return contaminated properties into productive use and make them an asset to the surrounding community. In fact, ChevronTexaco won an award from EPA in 2002 for being one of the first companies to pledge expedited cleanups of our remediation sites. We believe successful approaches from one regulatory program should be allowed in all EPA cleanup programs. For example, isolating a source of contamination is acceptable in Superfund and should be used, when appropriate, in RCRA as well. Regardless of the statutory authority on which the programs are based, clean-up decisions should be risk-based, use sound science and consider the intended end use of the property.
- *MTBE Remediation Success*—ChevronTexaco strongly believes that those responsible for releases of gasoline containing MTBE should be held accountable for clean-up efforts, and that existing laws are sufficient to compel those responsible. MTBE remediation efforts are best handled under the clean-up authorities of the respective state regulatory agencies. Current litigation against manufacturers only serves to distract parties from necessary remediation efforts and, if required, delay the return of those resources to beneficial reuse. ChevronTexaco supports a national MTBE phase-out and limited liability protection for manufacturers.
- *Water*—We support development of a consistent, scientifically-based policy to identify and remediate “impaired” water bodies. Responsibility for remediation should be assigned to dischargers in an amount that is in proportion to their contribution to the problem. Stormwater controls should rely on “best management practices” rather than strict end-of-pipe limits since stormwater is variable, unpredictable, and impossible to treat reliably.

GLOBAL ENERGY SECURITY:
“FUELING THE GLOBAL ECONOMY”

Globalization is making the world’s economies increasingly energy interdependent. Rising world demand for all forms of energy means that our nation will face increased competition for secure sources of energy. U.S. energy policy needs to reflect a new reality where global oil consumption is forecast to rise nearly 2% annually over the next two decades. ChevronTexaco looks forward to working with the Administration to reinforce partnerships that sustain our country’s *energy interdependence* and to codify strong investment frameworks around the globe that are built upon three foundations:

- Open markets
- Sanctity of contracts
- Transparent Application of Rule of Law

Energy Interdependence—USG foreign policy must reflect the critical role of energy interdependence in sustaining healthy economies.

- USG should seek bilateral policies that allow commercial stability and security of energy supply. Active dialogue with key suppliers and users, such as Russia and China, will need to be ongoing to help ensure stable markets.
- USG relationships with key energy suppliers, such as Canada, Mexico, Saudi Arabia, and Venezuela are essential to maintain reliable energy supplies. Foreign investment through collaborative partnerships will be necessary if these supplier countries are to make the requisite investment in energy infrastructure to maintain and expand production, while at the same time adequately provide for their local social expenditures, e.g. in education and health care.
- The USG should seek to expand its natural gas collaborations with suppliers such as Australia and Canada. With global natural gas demand projected to grow by 2.2% annually through 2025, Australia is ideally positioned to become a major global energy supplier.
- The USG should explore how to create a mutuality of interests with key energy producers where foreign investment is currently limited, e.g. Mexico.

Open Markets—Reduced trade barriers, price deregulation, and market-driven public investing are all prerequisites of a transparent business environment.

- The USG needs to support active participation in rules-based international institutions like the World Trade Organization (WTO), and should work actively with major energy suppliers such as Russia, Kazakhstan, and Saudi Arabia to ensure that they recognize the benefits of WTO membership and can take the necessary steps for accession requirements.
- Our public/private sector coalitions should support strong investment protection provisions that are modeled in the Central American Free Trade Agreement.
- Open markets provide level playing fields for U.S. companies and our competitors. Engagement with countries is more effective as a way promote acceptance into the global community than unilateral sanctions. The stepwise U.S.-Libya rapprochement that is exposing Libya to international best business practices (by re-engaging with U.S. companies and the U.S. educational system to develop its next generation of leaders) can serve as a model for other sanctioned countries.
- Liquefied Natural Gas (LNG) is growing in importance as a fuel. The U.S. should seek ways to facilitate efficient growth of LNG utilization by: a) encouraging/ streamlining approval processes for import/regasification terminals, b) seeking leadership opportunities in regional organizations (e.g. APEC) to facilitate policy development in permitting, transport, customs, and other areas that impact LNG production and shipping and c) engaging in a public education campaign on LNG.

Sanctity of Contracts—Contracts are the keystones for investments, and all contractual parties must be confident of agreed-upon commitments.

- A coordinated interagency process that leverages the strengths of individual USG agencies to partner with U.S. companies can provide maximum support for U.S. commercial projects.
- As new opportunities arise, the USG should encourage countries to develop contracts that provide fair rates of return for all parties, commensurate with risk.
- U.S. companies are looking to develop broad partnerships to ensure reliable energy supply to U.S. markets. Some specific ChevronTexaco opportunities to support future demand include:
 - award of the Kuwait Northern Fields
 - contract extension for the Saudi Partitioned Neutral Zone
 - timely expansion of Kazakhstan's Tengiz and the Caspian Pipeline Consortium (CPC) to facilitate moving new crude supplies to market.
- We note that failure to honor contractual terms, as has occurred in Ecuador (with unfair legal claims against our company), will discourage new investment or re-investment in energy resources by any company.

Transparent Application of Rule of Law—The USG should assist transitioning economies to develop the institutions and systems of good governance and support for the Rule of Law. This assistance provides an appropriate environment for ensuring the protection of investments, provisions for worker safety and security, and the environmentally sound development of energy resources.

- Public/private sector cooperation can be an effective method of delivering such assistance. For example, we participate with our host-government partners in the voluntary U.S.-U.K. Extractive Industries Transparency Initiative (EITI) and the G-8 Transparency Initiatives. These initiatives are making demonstrable progress to ensure that oil revenues are invested wisely and utilized for the benefit of a country.
- Good governance should extend to physical as well as fiscal security in the transparent development of energy resources. USG technical assistance to the Nigerian government to improve the way it provides security in areas such as the Niger Delta is critical not only for regional development, but to help calm jittery energy markets through secure production capacity.
- Critical signposts for new investment opportunities in high risk areas will be progress in judicial reform and recognition of property/shareholder rights. USG technical assistance is an important component to this progress.

THE GLOBAL BUSINESS CLIMATE:
“KEEPING THE BAR HIGH AND THE PLAYING FIELD LEVEL”

The globalization of commercial ties provides an important vehicle to enhance economic growth, promote understanding, reinforce alliances and, where necessary, help build political bridges. To be effective and mutually beneficial, global enterprise

needs a level playing field where the same rules apply to all participants, and the standards of behaviors are maintained at the highest levels. We urge the Administration to foster a favorable global investment climate. With the U.S. as one of the world's leading economies, the USG needs to develop innovative and collaborative approaches to promote sustainable economic growth, and it has a responsibility to ensure high standards and a level playing field. These approaches will need to focus on the rules of engagement for businesses around the world:

- International Trade Rules
- Corporate Governance
- Multilateral Organizations
- Tax policy

International Trade Rules: We urge the Administration to continue to ensure high standards of protection for U.S. investments and property rights overseas. The USG should demand non-discriminatory treatment, free transfers of profits and capital, protection from expropriation, and international arbitration in dispute resolution.

- We urge the USG to push forward on Bilateral Investment Treaties (BIT) that offer strong investment protection and serve as models for host country governments to design favorable investment environments. Where BITs have been negotiated, but are still pending ratification, (e.g. Russia), we encourage the USG to continue to work to bring these agreements into force.
- Free Trade Agreements (FTAs), both bilateral and regional, are excellent tools to encourage rules-based behavior and USTR is to be commended on its efforts to extend these agreements to governments who recognize the value of rules-based trade regimes.
- We urge the USG to ensure that Article 35 of the draft UN Convention Against Corruption is defined to prevent the use of U.S. courts as major forums for frivolous, private anti-corruption lawsuits.
- Judicial expansion of the scope of the Alien Tort Claim Act encouraging U.S. adjudication of foreign grievances creates a non-level playing field and undermines U.S. relations with transitioning nations.

Corporate Governance: The USG should identify and expand programs that encourage good governance. It should work to promote fiscal responsibility and transparency—through voluntary programs such as the U.S.-U.K. Extractive Industry Transparency Initiative and the G-8 Transparency Compact. These and related efforts are discussed in more detail under the Issue Paper: “Corporate Responsibility: Developing Innovative Partnerships to Promote Corporate Responsibility.”

In addition the USG should do the following:

- Promote the links between transparency, investment flows and economic performance by publishing the results of international surveys (e.g. GovernanceMetrics).
- Continue the State Department’s Corporate Excellence awards and invite other countries to establish similar programs.
- Award, and encourage others to award, contracts on an evaluation of the total value proposition and competency of bidders and the transparency of their bid to provide a requested service (as opposed to simply awarding contracts to low bidders)

Multilateral Organizations: Multilateral organizations such as the World Bank, the International Monetary Fund and the World Trade Organization (WTO) should help governments establish good policy mixes. The WTO must push for trade liberalization particularly in the agricultural sector. Debt relief must also be tackled in a systematic way.

- We ask the USG to actively participate in the multilateral organizations to ensure that policies actually support responsible growth through regular monitoring and feedback to the multilateral organizations. The USG should participate in new policy initiatives to bolster governance frameworks, insisting that the private sector be included as a critical stakeholder and client.
- Nongovernmental organizations (NGOs) and community groups should help local populations make lasting, sustainable improvements in their own economies. They, like all stakeholders, should be held accountable for their actions, and participate constructively in working with stakeholders, including corporations, to identify collaborative approaches to sustainable development.
- ChevronTexaco’s Angola Partnership Initiative, working with USAID and the UN Development Program, is focusing on a relief-to-development strategy that will allow this war-torn country to move beyond humanitarian relief efforts and spur sustainable investment in diverse sectors, e.g. in agriculture, to help An-

gola rebuild itself. We are pleased to share our learnings with other potential partnerships.

Tax Policy: U.S.-based businesses compete throughout the world with non-U.S. based businesses for market access, and exploration and production opportunities. The USG should promote tax policy which enables U.S.-based businesses to compete with its non-U.S. peers. This requires:

- Foreign tax credit rules which prevent double taxation.
- Tax treaties which reduce withholding taxes and other investment barriers.
- Avoiding unnecessarily complex tax rules and tax reporting.

These activities create U.S.-based jobs and ensure availability of energy resources to the U.S. If U.S.-based businesses are subject to a higher tax burden than their competitors these benefits can be lost.

LEVERAGING TECHNOLOGY:
ENSURING SUSTAINABLE ENERGY SUPPLY AND USE

The energy industry is technology intensive. Applied research and development (R&D) and complex engineering have always been essential to finding, developing, and using energy resources. While energy companies have historically met the technical challenge, industry consolidation has narrowed the R&D base. At the same time, industrial R&D has become globalized. These trends threaten to challenge U.S. technology leadership, unless we create new options for supporting research and development. The private sector needs increased partnerships between companies, national laboratories, universities, and public agencies to broaden its technical capabilities. The USG should encourage public-private partnerships to maintain U.S. leadership in energy technology and promote competitively bid partnerships between government and industry to advance and demonstrate technology.

Sustaining U.S. Technology Leadership—The technologies that will secure America's energy future require a strong scientific and engineering base. In the face of growing challenges, the USG should build America's intellectual capital by vigorously participating in energy-related R&D and by bearing a reasonable share of costs for energy programs that serve the national interest but are not yet commercially viable. The USG should continue to support science and engineering education to keep American business, universities and government laboratories technologically competitive as other countries increase their own technological capability.

Energy companies apply technology to provide diverse, secure energy supplies that are economically and environmentally sustainable. Technology is generally leveraged in three key areas: accessing hydrocarbon resources, providing clean fuel and power, and managing emissions and waste products.

Assessing Hydrocarbon Resources—The challenge for our industry is maximizing oil and gas recovery from existing production areas while extending the frontiers for exploration and development. Enhanced recovery technologies allow more oil and gas to be recovered from existing fields, while precision techniques such as horizontal drilling allow production with smaller environmental footprints.

The USG should:

- Encourage responsible development of resources both offshore and continental U.S., and work to inform the media and local communities about new technical capabilities that enhances production while minimizing environmental impact.
- Partner with the private sector to develop precision technologies for finding and producing hydrocarbon resources.

ChevronTexaco's joint projects with National Laboratories in areas such as advanced computing and seismic imaging demonstrate the public-private collaboration needed to advance exploration and development technology. Technologies for arctic development, deepwater production, heavy oil commercialization, and oil sands development will diversify hydrocarbon resources while adding significant new reserves.

Providing Clean Fuel and Power—The energy industry is actively developing technologies for cleaner burning fuels, high performance fuels, and alternative fuels. While some technology is proprietary, the work is highly collaborative between regulators, the auto industry, energy companies and others. In addition to vehicle fuels, technology is advancing for cleaner power generation, particularly from natural gas or gasification of other hydrocarbons. The USG should:

- Avoid mandating or subsidizing consumer use of specific fuels.
- Cooperate with local communities and authorities to ensure timely construction and operation of re-gasification and distribution facilities such as LNG plants.

- Continue public-private research partnerships for clean energy systems such as hydrogen fuel cells and other advanced alternative fuels.

Looking further to the future, numerous public-private research projects are testing the feasibility of hydrogen and other alternative fuels. ChevronTexaco participates in these projects, including leadership of a DOE-industry consortium to demonstrate hydrogen infrastructure and fuel cells.

Managing Air and Water Emissions and Waste Products—Both greenhouse gas and water issues transcend company and industry boundaries. Acting domestically and internationally, the USG should:

- Continue its research activities with other organizations to establish the scientific basis for policy decisions and mitigation requirements
- Partner with the energy industry to develop economically and environmentally sustainable policies regarding carbon capture and storage.

Energy companies have vigorous engineering programs to reduce our own emissions and waste streams and the emissions from our products. On the global issue of greenhouse gases, for example, we pursue technology to reduce emissions at the source (e.g., more efficient use of fuel) as well as remove them from the environment once produced (e.g., CO₂ sequestration in oil and gas fields). For example, oil field injection of CO₂ is a key feature of ChevronTexaco's activities in Western Australia and in other projects for enhanced oil recovery. ChevronTexaco also participates in the Department of Energy's Carbon Capture Project, which is now entering Phase 2 of a multi-year program.

Water remediation and re-use is a major, parallel area of technical focus in production operations and refining. Since technology for water issues is in its early stages, government and industry have an opportunity to collaborate in mapping technology pathways and developing policies. In addition to its own technology programs, ChevronTexaco is in exploratory discussions with the National Laboratories about joint programs for water treatment and use.

CORPORATE RESPONSIBILITY:

“DEVELOPING INNOVATIVE PARTNERSHIPS TO PROMOTE CORPORATE RESPONSIBILITY”

Over the past decade, corporations have addressed a range of corporate responsibility issues, ranging from corporate governance and transparency to environment and human rights. Corporations, either through their own initiatives or through public-private partnerships, have focused their attention on how they can be a positive force for society and contribute to economic growth, social stability and sustainable development.

ChevronTexaco is an acknowledged leader in corporate responsibility. Indeed, we see corporate responsibility and business success as mutually reinforcing—the success of our business is directly linked to the economic, social and environmental health of the communities where we operate. ChevronTexaco stands ready to work with the Administration, policymakers and other stakeholders to develop effective and innovative approaches to promote corporate responsibility. ChevronTexaco believes that a sound USG approach to corporate responsibility should:

- *Encourage voluntary efforts* that offer creative solutions and allow for flexibility in implementation given the complex operating environments facing companies in different sectors around the globe.
- *Contribute to sustainable solutions* to enable communities and stakeholders, including civil society, to build their capacity and contribute to economic growth.
- Support efforts for voluntary partnerships to *increase revenue transparency* (e.g. Extractive Industry Transparency Initiative).

Encourage Voluntary Efforts. The USG should support voluntary public-private efforts rather than pursue regulatory mandates. Unlike regulatory mandates which impose one-size-fits-all approaches, voluntary efforts permit the flexibility necessary to adapt to local, often complex and diverse, operating conditions. They also provide corporations and their employees with ownership over implementation. Voluntary approaches can also stimulate creative discussions and innovative solutions that leverage individual organizational capabilities and commitment. Incentives and recognition for performance, such as the State Department's Award for Corporate Excellence, should be used to encourage corporate efforts.

- *Human Rights.* The USG should continue its leadership role in supporting human rights around the globe through bilateral and multilateral diplomatic channels. Continued USG funding of programs that build the capacity of civil society, the media, and the judiciary are key to supporting human rights. Our commitment to this issue is demonstrated in our conduct, through our participa-

tion in the Voluntary Principles for Security and Human Rights dialogue process, and support for the Global Sullivan Principles. ChevronTexaco pledges to work collaboratively with the USG, host governments, and local communities to support universal human rights.

- *HIV-AIDS.* The USG should support public-private partnerships to combat HIV-AIDS. With programs in nearly 100 countries totaling over \$3.2 billion since 1986, the U.S. government is at the forefront of responding to the global pandemic of AIDS. USG support for public-private partnerships could offer an additional opportunity to leverage resources and expertise. ChevronTexaco, with our strong presence in Africa, currently works with host governments, NGOs, multilateral agencies and international initiatives on HIV-AIDS and stands ready to explore partnership opportunities with the USG.

Contribute to Sustainable Solutions. The 2000 World Summit for Sustainable Development was a watershed event that highlighted the need to build both public-private partnerships and local capacity to enable sustainable development. The USG should support public-private partnerships that promote economic growth, social development and environmental stewardship. ChevronTexaco stands ready to work with the USG on innovative and progressive approaches to sustainable development.

- *Community Engagement.* The USG should support public-private efforts to stimulate economic growth through education, focused health programs and the development of small and medium sized businesses through training, business development services and micro-credit programs. USAID's Global Development Alliance should receive continued support. Combining public resources with those of business to leverage complementary skills and resources can lead to sustainable results. ChevronTexaco stands ready to work with the USG to partner on programs, such as our Angola Partnership Initiative with USAID which is helping people improve their lives by building the human and institutional capacity necessary to support economic growth.
- *Stakeholder Engagement.* The USG should use its convening power and diplomatic resources to lead multi-stakeholder dialogues on corporate responsibility issues. The USG can provide a neutral forum to address tough issues and exchange best practices. Its convening role on the Voluntary Principles on Security and Human Rights is a good example. The USG should also work with existing mechanisms, such as the OECD, to encourage greater dialogue on corporate responsibility.

Support Transparency Efforts. The USG should continue its support for voluntary partnerships to increase revenue transparency. The U.S.-U.K. Extractive Industry Transparency Initiative (EITI) and the G-8 Transparency Compacts are two good examples of these efforts. The USG should also use its diplomatic leverage to encourage governments to participate in these efforts. ChevronTexaco was proud to have participated in the constructive discussions that launched the EITI and remains supportive of the process.

OPINION EDITORIAL: THE NEW ENERGY EQUATION
BY DAVE O'REILLY, CEO OF CHEVRONTExACO

THE NEW ENERGY EQUATION:
WISE ENERGY USE AT HOME AND GLOBAL ACCESS, DIVERSIFICATION AND SECURITY

Energy is essential to economic health and the quality of life everywhere in the world. Energy is, quite literally, the lifeblood of the U.S. and the global economy.

Today, America and the world face a new equation in terms of both the stability of the supply and the price of energy. This new equation results from increased and sustained demand particularly from China and India, declining sources of supply from traditional energy sources, and increased geopolitical risk in areas where energy is produced. America's energy policy must recognize the new reality and acknowledge that while our nation strives to become more energy self-sufficient, our policies must recognize that America will continue to rely on international energy supplies to meet domestic needs.

America's energy policy can no longer stop at the water's edge. We need a global, strategic approach to ensure continued access to diverse international energy supplies, particularly as competition for these supplies intensifies. At the same time we need to implement more aggressive policies at home to reduce consumption, increase energy efficiency and develop alternative supply sources. Trade and investment issues, tax policy, foreign policy, bilateral, regional and multilateral relationships,

and U.S. Government international advocacy efforts must be more effectively and strategically integrated with our traditional domestic energy agenda.

The Federal Reserve recently concluded that higher energy costs are constraining consumer and business spending in the United States. The International Energy Agency has also acknowledged that higher oil prices are dampening global economic growth. Given the changed circumstances we face today, it is critical to begin to explore new ways of approaching the energy debate, to develop a more robust and coordinated set of policy options and to organize strategically the U.S. Government's energy policymaking apparatus to ensure that America has stable, predictable and affordable energy to fuel sustained economic expansion.

WE MUST RECOGNIZE THAT THE UNITED STATES AND THE WORLD
ARE ENERGY INTERDEPENDENT

Today, America relies on energy from countries around the globe, and will continue to do so in the future. Almost two-thirds of the total U.S. energy consumed comes from oil and natural gas. And with U.S. energy consumption expected to increase by 27% over the next 15 years, the nation will continue to rely heavily on oil and natural gas to meet that growing demand (Chart 1)—with much of the oil and natural gas imported.

The United States consumes much more oil than it produces (26 percent of the world's consumption versus 10 percent of world oil production), and consumption is high relative to proven reserves (Chart 2). While U.S. natural gas production is much closer to consumption, there will be an increasing need for supplies of imported natural gas. The U.S. consumes 25 percent of the world's natural gas, but has only 3 percent of the world's reserves (Chart 3). This means that over time the United States will be more dependent on natural gas in the form of Liquefied Natural Gas (LNG), the form of natural gas that can be transported around the globe.

As U.S. domestic oil production has declined, the United States has relied more and more on imported crude oil and products (Chart 4). While the United States needs to conserve oil and increase its domestic supply, it is apparent that the United States will continue to significantly rely on imports. Thus, for both natural gas and oil, the United States needs to recognize it is interdependent with the rest of the world for supply of these two important fuels. We need a comprehensive policy that reflects this reality.

A NEW GLOBAL, STRATEGIC APPROACH TO AMERICA'S ENERGY SECURITY IS REQUIRED

ChevronTexaco hopes to be part of the solution to the energy challenges America faces. Our ability to do so depends upon working with the Administration and Congress to build support for and consensus around a shared national goal of American businesses and consumers having stable, predictable and affordable energy supplies. To advance this goal, requires us to look at three critical sets of issues.

- Wise management of energy resources within the United States, including ensuring sufficient and diverse supplies, the responsible use of energy (conservation) and the responsible stewardship of the environment.
- To meet America's energy security needs, we need to diversify and improve access to international energy supplies through constructive international engagement.
- Finally, we need to support those enablers that promote the wise use of energy and ways to responsibly manage energy resources around the globe through leveraging technology to ensure sustained energy supply and use and developing effective and innovative public-private partnerships to promote corporate responsibility.

ORGANIZING FOR SUCCESS TO MEET THE CHALLENGE OF THE NEW ENERGY EQUATION

How America organizes to address the energy challenge we face is critical going forward. For the United States to be able to develop and implement a global and truly strategic energy policy requires consideration of new organizational models. Today, U.S. energy policy is managed through a number of federal agencies including the Department of Energy, Department of the Interior, Department of Commerce, Department of State, and Department of the Treasury, as well as agencies and groups such as EPA, OMB, USTR, NSC, and the NEC. There are not institutional mechanisms to ensure that these important components of the broader policy—our environmental policy, our foreign policy, our trade policy, our security policy and our domestic energy production, access and use policy—are brought together to advance the common goal of reliable and affordable energy supplies. The global nature of the challenge and the domestic and international components of the solu-

tion require us to develop organizational models that will ensure a strategic, seamless approach.

The enclosed papers provide concrete and practical recommendations that we believe, if taken together, will help safeguard America's energy security for years to come. All of us at ChevronTexaco stand ready to work with the Administration and Congress on this critical challenge.

STATEMENT OF DR. R. NEAL ELLIOTT,
AMERICAN COUNCIL FOR AN ENERGY-EFFICIENT ECONOMY

The American Council for an Energy-Efficient Economy (ACEEE) appreciates the opportunity to provide comments regarding global energy trends and their potential impact on U.S. energy needs, security and policy. ACEEE is a non-profit organization dedicated to increasing energy efficiency as a means for both promoting economic prosperity and environmental protection. We were founded in 1980 and have developed a national reputation for leadership in energy efficiency policy analysis, research and education. We have contributed in many ways to congressional energy legislation adopted during the past 20 years, including the current energy bills, the Energy Policy Act of 1992, the National Appliance Energy Conservation Act of 1987, and the Energy Title of the 2002 Farm Bill. We are also an important source of information for the press and the public on energy efficient technology, policies, and programs.

ACEEE remains concerned about the continuing imbalance between energy supplies of natural gas, oil and electricity, and rapidly growing domestic and foreign demands for these energy resources. ACEEE research has shown that energy efficiency is the most viable near-term strategy for rebalancing energy markets. Energy efficiency is the only near-term option for moderating energy prices, and is also vital to stabilizing longer-term energy markets. Additional energy supplies, either domestic or imported require at least three years to bring to the market, with many resources, such as additional Alaska gas and oil, taking on the order of a decade to bring to market.

Recent ACEEE analysis of the impact of energy efficiency on natural gas markets shows that if we can reduce gas demand by as little as 4% over the next five years, we can reduce wholesale natural gas prices more than 20%. These savings would put over \$100 billion back into the U.S. economy, at a cost of \$30 billion in new investment, of which less than one-quarter would be public funds at a combination of the federal and state levels.

Moreover, this investment would help bring back U.S. manufacturing jobs that have been lost to high gas prices, and would help relieve the crushing burden of natural gas costs experienced by many lower-income households. Importantly, much of the gas savings in our analysis come from electricity efficiency measures, because so much electricity is generated by natural gas, often inefficiently.

It is important that assessments of energy resource options fairly treat energy efficiency in national energy forecasts. Efficiency resources are more flexible and in most cases less costly than are new supply resources. In the past, the National Energy Modeling System (NEMS) used by the Energy Information Administration (EIA) has not adequately characterized the potential for energy efficiency. While significant improvements have been made in recent years, such as the more robust characterization of combined heat and power (CHP) and electric motors in the Industrial Demand Module, ACEEE feels additional work needs to be done to bring energy efficiency resources into parity with supply resources across all the modules. Also, major structural changes are taking place in U.S. energy markets. EIA needs updated modeling capability to reflect adequately these new market realities.

However, for EIA to better characterize energy efficiency, it is important that they have adequately detailed consumption data available and sufficient staff resources to modify the NEMS model to capture these market effects. Unfortunately, budget cuts in recent years have reduced the sample size of the three important consumption energy surveys—Manufacturing, Residential and Commercial Buildings. In addition, as a result of limited resources, the questions asked in these surveys are now less detailed and the reports are taking longer to issue. It is important that funding be restored to the real dollar levels from the mid-1990s if not increased.

It is not just quality consumption data that is needed for supporting sound energy policies. The supply data collected by EIA is also critical to functioning energy commodity markets. In particular the frequency and reliability of natural gas market data has become a problem for smoothly functioning natural gas markets. The natural gas storage and consumption data collected and reported by EIA on a weekly basis is neither frequent nor reliable enough to allow natural gas markets to func-

tion smoothly, and has contributed to price volatility. ACEEE supports providing EIA additional resources so that they can collect and report natural gas data more frequently and in greater detail.

Finely, policy makers in Washington need new capabilities to do policy analysis to explore the various options presented to them. Unfortunately, NEMS is a forecasting, not a policy assessment tool. The program is ill suited to exploring various policy scenarios. Congress should support EIA in developing a robust suite of policy analysis tools to complement their forecasting ability. Failing that, consideration should be given creating this policy analysis capability somewhere else within the federal government, either at another agency or within the National Laboratory system.

Thank you for the opportunity to provide these comments. We would welcome the opportunity to explore them in greater detail at the committee's convenience.

STATEMENT OF MARVIN S. FERTEL, SENIOR VICE PRESIDENT, NUCLEAR GENERATION,
AND CHIEF NUCLEAR OFFICER, NUCLEAR ENERGY INSTITUTE

SUMMARY

The Energy Information Administration (EIA) will release the Annual Energy Outlook 2005 (AEO 2005) next week, and the Senate Energy and Natural Resources has requested testimony about EIA's forecasting through 2025. Although EIA's forecasting of nuclear power's contribution to U.S. electricity supply has improved in recent years, the Nuclear Energy Institute (NEI)¹ believes that EIA's outlook, particularly with respect to new nuclear plant construction, is based on erroneous assumptions.

NEED FOR ACCURATE ANALYSIS AND FORECASTING

There is increasing evidence that the United States faces serious energy supply and delivery problems. Even assuming successful conservation and efficiency programs, U.S. dependence on imported oil is at a historic high. Natural gas prices across the country have increased dramatically. The transportation infrastructure for delivery and natural gas requires significant expansion. The transmission infrastructure necessary to move electricity within and between states and regions is seriously overloaded, placing reliability at risk.

The imminent threat to reliable supplies of energy at stable, predictable prices is generating interest in new national energy policy legislation. The appropriate authorizing committees in both the Senate and House are holding hearings. At times like these, policymakers in the Administration and the Congress must have access to the most accurate analysis and forecasting possible. In the case of nuclear energy, the EIA's forecasts are not accurate, appear based on hypothetical speculation, and do not reflect realistic analysis of the current status of nuclear energy in the United States.

EIA'S FORECAST FOR NUCLEAR ENERGY

Each year, EIA's Office of Integrated Analysis and Forecasting publishes an annual forecast of U.S. energy supply and demand called the Annual Energy Outlook (AEO). AEO 2005 provides projections of energy supply and demand in all consuming sectors and for all fuels through 2025. This year's Outlook projects that total nuclear generation will grow from 764 billion kilowatt-hours in 2003 to 830 billion kilowatt-hours in 2025.

This EIA projection contrasts sharply with EIA's forecasts several years ago. AEO 1999 predicted that 50,800 megawatts of nuclear capacity would be retired by 2020. The following year, the publication predicted that 42,700 megawatts would be retired. AEO 2001 forecast shutdown of 28,100 megawatts, and AEO 2002 forecast shutdown of 9,700 megawatts of nuclear generating capacity. These wildly divergent results were produced through a combination of analytical errors, including use of out-of-date data, imposition of arbitrary additional costs, and "double-counting" of additional costs.

EIA's assessment of the outlook for the existing U.S. nuclear power plants nonetheless has improved dramatically. AEO 2005 predicts nuclear generating capacity

¹ The Nuclear Energy Institute (NEI) is the organization responsible for establishing nuclear industry policy on matters affecting the nuclear energy industry. NEI's members include all companies licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect-engineering firms, fuel fabrication facilities, materials licensees, and other organizations and individuals involved in the nuclear energy industry.

will increase from 99.2 gigawatts in 2003 to 102.7 gigawatts in 2025 as a result of uprates of existing plants. It projects that all existing nuclear plants will continue to operate.

The Nuclear Energy Institute commends EIA for recognizing that the 103 nuclear operating reactors that supply 20 percent of U.S. electricity will continue to operate to the end of their initial 40-year license terms and, in virtually all cases, will renew their licenses and continue to operate for an additional 20-year period. However, NEI believes there is substantial room for improvement in EIA's outlook for new nuclear plants in the United States.

THE OUTLOOK FOR NEW NUCLEAR UNITS

The Annual Energy Outlook 2005 assumes no new nuclear power plants will be built before 2025 in the United States. The NEMS (National Energy Modeling System) model reaches this conclusion because EIA analysts have assigned an unrealistically high, and inflated, capital cost to new nuclear generating capacity. The EIA assumes new nuclear plants would have an overnight capital cost of \$1,928 per kilowatt of capacity.

NEI commends EIA for its initiative, during 2003, to conduct a series of workshops on the issue of new nuclear plant capital cost. AEO 2004 included a summary of those workshops, which reflected industry's view that new nuclear plants in the United States could be built for \$1,400 to \$1,500 per kilowatt (including first-of-a-kind costs for the initial reactors of a series) and \$1,100 to \$1,200 per kilowatt (for the nth of a kind). Unfortunately, these cost estimates, which have a strong factual basis, were not reflected in either AEO 2004 or AEO 2005.

The summary of the 2003 workshops in AEO 2004 acknowledged that "there is reason to believe that new reactors will be less costly to build than those currently in operation in the United States. Over the past 30 years, there have been technological advances in construction techniques that would reduce costs. In addition, the simplified, standardized, and pre-approved designs clearly result in cost savings."

EIA then ignored this finding and assumed that new nuclear plants would experience the same delays, lengthy construction periods and high costs experienced by some of the plants built in the 1980s and 1990s. Consequently, it estimated that a new plant would face overnight capital costs in the range of \$1,928 per kilowatt.

The industry believes there is ample evidence to demonstrate that EIA's approach is flawed, and that there is a reasonably solid basis for industry's capital cost estimate. Two examples are cited here: the AP1000 design developed by Westinghouse, and the Advanced Boiling Water Reactor (ABWR) developed by GE Nuclear Energy.

THE WESTINGHOUSE AP1000

Westinghouse is currently pursuing Nuclear Regulatory Commission design certification of its AP1000 nuclear power plant. The AP1000 is a 1,117-megawatt advanced light water reactor. It is essentially a higher power version of Westinghouse's 600-megawatt design, the AP600, which the NRC certified in 1999. Over \$400 million was invested in developing and licensing the AP600 design, including an extremely detailed cost database comprising more than 1,900 commodity categories and 25,000 specific items. The cost estimate was verified by Westinghouse, several international architect-engineers, the Electric Power Research Institute, and several utilities. A comparably detailed cost estimate was prepared for the AP1000 by modifying the AP600 estimate to reflect the design changes.

In 2002, an industry team—comprised of Westinghouse, seven major U.S. power companies and architect-engineer Bechtel—completed a \$1-million re-evaluation of the AP1000 reactor design. As part of that re-evaluation, Bechtel performed a thorough review of the modifications made to the original cost estimate and, after making some minor adjustments, endorsed the AP1000 cost estimate.

Although the specific numbers are proprietary information, the overnight capital cost for building the first two AP1000 reactors at one site is less than \$1,400 per kilowatt. This includes all of the first-time costs for completing design, engineering and licensing of the first project. After the first few projects have been completed, the capital cost for later plants will be approximately \$1,000 per kilowatt, which is competitive with other sources of baseload electricity. Once those first reactors are built and capital costs reach the \$1,000-per-kilowatt range, all future plants would be financed and built without federal government financial assistance.

The Westinghouse-Bechtel estimate of less than \$1,400 per kilowatt has a solid analytical basis, has been peer-reviewed, and reflects a rigorous design, engineering and constructability assessment.

THE GE NUCLEAR ENERGY ABWR

GE Nuclear Energy and its partners have built several ABWRs in Japan, and are building two reactors in Taiwan (the Lungmen project). In 2002, GE and Black & Veatch (B&V) completed an independent cost estimate of the ABWR. This study resulted in volumes of data, including quantities, vendor costs and construction labor rates. The source of information for every piece of data is referenced. Most references for quantities of materials are to the Lungmen project database, and thus accurately reflect what would be required to build a plant.

This cost estimate was reviewed and re-reviewed by GE, B&V and a U.S. utility. As the estimate was based on actual experience from current and previous ABWR projects, it is considered to be solid.

The bottom line: a single unit ABWR could be built in the U.S. for \$1,445 per kilowatt on an overnight basis. Two units on the same site roughly one year apart would have an average cost of \$1,300 per kilowatt. These estimates are for a 1,450-megawatt reactor and include owner's costs, supplier profit and contingency. These costs are slightly higher than the estimates for the AP1000 because the Westinghouse reactor incorporates a number of so-called passive safety features that reduce the total capital cost. GE Nuclear Energy also is developing a boiling water reactor design that incorporates similar advanced passive safety features.

FINLAND: COMPARISON OF GENERATING OPTIONS

[With Emissions Trading]
[in Euro/MWh]

	Fuel	O&M	Capital	Emissions Allowances	Total
Nuclear	2.7	7.2	13.8		23.7
Gas	23.4	3.5	5.3	7.0	39.2
Coal	13.1	7.4	7.6	16.2	44.3
Peat	17.9	6.5	10.2	19.6	54.2
Wood	23.1	8.2	13.0		45.3
Wind	10.0		40.1		50.1

Note: All generating technologies at 8,000 hours per year; wind at 2,200 hours per year.
Source: TVO

The company expects that overnight capital cost for this design will be approximately 20 percent lower than the ABWR.

In addition, EIA ignores real experience from overseas, which demonstrates clearly that new nuclear power plants are the most economic option for new generating capacity and not, as EIA suggests, the least economic. The chart above shows the results of the economic assessment conducted by TVO, the Finnish electric power company, which led to its decision in 2004 to order and build a fifth nuclear power plant. This analysis shows that a new nuclear power plant is markedly more economic than the other alternatives and lends credence to the capital cost estimates developed by the U.S. nuclear industry.

The Nuclear Energy Institute believes EIA would better serve the policy community by using real-life analysis and cost information rather than its own hypothetical assumptions, which prejudice its forecasts against nuclear power.

The continuing prejudice against new nuclear plant construction reflected in EIA's Annual Energy Outlook has serious negative consequences. Once such example of erroneous EIA data used in the energy policy debate occurred in 2003 when the Senate evaluated whether a federal production tax of \$18 per megawatt-hour for the first eight years of operation for the first 6,000 megawatts of new nuclear capacity built would stimulate new nuclear generating capacity in the United States.

The EIA report (SR/OIAF/2004-02) concluded that the production tax credit would, in fact, stimulate construction of 6,000 megawatts of new nuclear power capacity, but that further expansion beyond 6,000 megawatts would not occur because new nuclear plants still would not be economic. The EIA analysis was incorrect because EIA again used inflated assumptions about the capital cost of new nuclear power plants and rejected the logic that, as more plants are built, capital costs would decline making the next units less expensive.

It is not difficult to predict what the EIA's NEMS model would forecast if EIA staff used more reasonable and realistic cost estimates for new nuclear plants. In 2002, the Electric Power Research Institute used the NEMS model to forecast the amount of new nuclear capacity that would be built using more reasonable capital

cost assumptions than EIA. The result: At \$1,250 per kilowatt, 23,000 megawatts of new nuclear capacity would be built by 2020. At \$1,125 per kilowatt, 62,000 megawatts of new nuclear capacity would be built by 2020.

CONCLUSION

Given the potential importance attached to the Energy Information Administration's forecasts, NEI believes it is important that these forecasts have a sound factual and analytical basis. At a minimum, NEI urges that EIA's forecasting function would benefit from rigorous peer review of all EIA's nuclear-related assumptions and methodologies, and peer-reviewed development of new economic models better able to simulate the dynamics of competitive electricity markets, the performance of existing nuclear power plants and the timing for construction of new nuclear units.

STATEMENT OF DERON LOVAAS, VEHICLES CAMPAIGN DIRECTOR, NATURAL RESOURCES DEFENSE COUNCIL (NRDC) AND ANN BORDETSKY, POLICY ANALYST (NRDC)

On behalf of the Natural Resources Defense Council (NRDC), a conservation organization with more than 700,000 members, thank you for the opportunity to submit testimony to the Senate Energy and Natural Resources Committee for the February 3rd hearing on the 2005 Global Energy Outlook.

The bottom line is simple and alarming—America's dependence on oil is a threat to our national security, our economy as well as our environment. Growing demand and shrinking domestic production means America is importing more and more oil each year—much of it from the world's most unfriendly or unstable regions. In 2004 the United States spent more than \$18 billion per hour on foreign oil¹ and more than \$36 billion on Persian Gulf imports alone.² Last year Federal Reserve Chairman Alan Greenspan called the higher cost of imported oil a tax on U.S. residents that has cut into our national GDP, warning that geopolitical tension is a serious concern and that adverse economic impacts for the U.S. will intensify if current trends in oil demand and prices continue.³

And there is increasing evidence that the era of cheap oil is over, with \$20-to \$25-per-barrel oil becoming a thing of the past. Global consumption is quickly outpacing spare production capacity and investment in future capacity is struggling to keep up with rising demand. The United States must face the prospect of oil prices remaining at \$40 per barrel.⁴ This is especially likely as OPEC, whose oil export revenues grew by 42 percent to \$338 billion in 2004, shifts its supply policy to lock in the higher prices.⁵

Our oil dependence also exacts a heavy toll on the environment. It helps make the United States the world's largest emitter of carbon dioxide, responsible for one-fourth of the world's total global warming pollution.* It causes serious air and water pollution, and it is the source of constant pressure to exploit our last precious wild lands. As our petroleum demand intensifies, Americans will remain exposed to the environmental costs and the harmful public health impacts associated with our dependence on oil.

Recent attacks on global oil infrastructure and subsequent spikes in domestic oil and gasoline prices provide clear evidence of the vulnerability that comes with extreme dependence on petroleum. Furthermore, terrorist organizations now recognize that oil is a lifeline of the United States and are well aware that one successful strike could take a million barrels per day or more of Saudi oil off the global market for months. That is just one possible event that could send oil prices soaring to \$80

¹Import spending estimates based on 2004 petroleum supply and price data provided by Energy Information Administration, January 2005 Short Term Energy Outlook, <http://www.eia.doe.gov/emeu/steo/pub/steo.html>.

²Import spending calculated based on EIA 2004 data on U.S. monthly crude oil imports (excluding SPR), crude oil WTI spot price, and percent U.S. imports from the Persian Gulf, <http://www.eia.doe.gov/emeu/international/petroleu.html#IntlTrade> and http://www.eia.doe.gov/oil_gas/petroleum/info_glance/importexport.html.

³Federal Reserve Chairman Alan Greenspan, October 15, 2004 and statement before the National Italian American Foundation in Washington, DC, on Oct. 15, 2004.

⁴Energy Information Administration, Short Term Energy Outlook, January 2005. EIA projects 2005-06 crude oil prices of \$42 to \$43 per barrel.

⁵Mouawad, Jad, "Saudis Shift Toward Letting OPEC Aim Higher," *New York Times*, January 28, 2005.

*Carbon Dioxide Information and Analysis, Oak Ridge National Laboratory, <http://cdiac.esd.ornl.gov/trends/emis/top98.tot> accessed on January 31, 2004.

per barrel in today's dollars, as the U.S. experienced at the height of the second oil crisis. Today, oil price spikes easily send jitters through the U.S. market, while our military expenditures in oil supplying regions continue to grow and our dependence is quickly becoming a key target for those who wish us harm.

That is why Congress must act immediately by making a national commitment to save at least 2.5 million barrels per day by 2015—an achievable and important first step toward a more secure energy future. There is burgeoning, bi-partisan support for taking such a step. For example, the National Commission on Energy Policy (NCEP)—composed of industry, government, conservation and academic officials—just completed an important report which identifies some opportunities for possible consensus on challenging energy policy questions.⁶ And NRDC recently joined an energy freedom initiative with security hawk groups, including the Institute for the Analysis of Global Security (TAGS), the Center for Security Policy and the National Defense Council Foundation (NDCF), focused on relieving the United States of our intense dependence on oil.

CURRENT DEMAND TRENDS

Here at home, while domestic production peaked in the 1970s, our consumption continues to grow at break-neck speed. According to last year's Annual Energy Outlook (AEO 2004), in 2025 the United States is projected to consume 44 percent more oil than we do today or 28.3 million barrels of oil per day; domestic production will meet a mere 30 percent of the total need (see graph below).*

Other growing nations will increasingly compete with the U.S. for the oil on the global market. Oil consumption by industrializing nations is expected to double over the next 25 years, from 15 to 32 million barrels a day. To meet projected world demand of 118 million barrels a day in 2025, global oil output would have to expand by 40 million barrels per day or 51% between 2002 and 2025.

Oil demand in China is especially likely to heat up. While per capita petroleum consumption is just six percent of the U.S. figure, rapid industrialization and a growing consumer culture mean China's demand for imported oil is projected to grow from less than 2 million barrels per day in 2004 to nearly 8 million barrels per day by 2020 (see graph below).⁷ While U.S. import dependence will rise to nearly 70 percent by 2025, India already imports 70 percent of its oil and the import share in China is expected to grow from 40 to 75 percent over the same time period.⁸ Business as usual keeps the United States on a path fraught with increasingly tight competition with other oil-needy nations.

This challenge is not lost on the Chinese government. In recent years China has been scouring the globe for oil supplies, including the Western Hemisphere (most notably in Canada and Venezuela).⁹ With its oil demand growing 18 percent in 2004, China is moving quickly to secure exclusive access to future oil supplies by financing strategically located pipelines, expanding its oil companies, and contracting with the key oil producing regions across the globe.¹⁰ Fortunately, China recognizes that its energy needs must also be met through efficiency, and in 2004 it took an important step towards reducing booming demand by setting vehicle fuel economy standards that are more stringent than those in the United States.¹¹

So business as usual means rapidly growing global consumption and intensifying competition for oil that will boost prices and increase the potential for conflict between nations addicted to this resource.

THE GRIM SUPPLY PICTURE

Even in the context of higher prices, it is clear that drilling for oil in the United States will not address the challenges of petroleum dependence, as the graph below shows. For example, while some argue that there are 16 billion barrels of "technically recoverable" oil under the Arctic National Wildlife Refuge's coastal plain, the

⁶ *Ending the Energy Stalemate: A Bipartisan Strategy to Meet America's Energy Challenges*, December 2004.

* All graphs have been retained in committee files.

⁷ International Energy Agency cited by Interfax, "Foreign Investment to Play Key Role in Development of China's Oil and Gas," China Weekly Energy Report, May 22-28, 2004.

⁸ Manjeet Kripalani, Dexter Roberts, Jason Bushm, India And China: Oil-Patch Partners?, *Businessweek*, February 7, 2005.

⁹ Luft, Gal, "In Search of Crude: China Goes to the Americas," Institute for the Analysis of Global Security, <http://www.iags.org/n0118041.htm>

¹⁰ Romero, Simon, "China Emerging as U.S. Rival for Canada's Oil," *New York Times*, December 21, 2004.

¹¹ Bradsher, Keith, "China Sets its First Fuel Economy Rules," *New York Times*, September 29, 2004.

U.S. Geological Survey's estimate of the amount that could be recovered economically—that is, the amount likely to be profitably extracted and sold—is much smaller and represents less than a year's oil supply. Moreover, it would take 10 years for any Arctic Refuge oil to reach the market, and even when production peaks—in the distant year of 2027—the refuge would produce less than 3 percent of Americans' daily oil demand. Whatever oil the refuge might produce is simply irrelevant to the larger issue of meeting America's future energy needs.

Furthermore, today's global oil use outpaces new oil discoveries, with the world using about 12 billion more barrels per year than it finds.¹² OPEC is quickly exhausting excess production capacity, allowing for little relief of demand, and despite Saudi Arabia's efforts to cushion the market, global capacity utilization remains at 99 percent in 2005.¹³

Given booming demand projections and high prices that already pinch the economy, what are the prospects for increasing oil supply? The reality is that the United States is inexorably headed towards greater dependence on hostile regions of the world to slake our thirst for oil. The Middle East has two-thirds of the world's proven oil reserves.¹⁴ Persian Gulf OPEC states already supply the United States with 2.5 million barrels per day—25 percent of our daily imports.

The future looks to bring more of the same: Last year's AEO projects that the Middle East will produce 36 percent of the world's oil in 2025 and together with other OPEC nations would control 46 percent of the global oil market.¹⁵ To meet demand, OPEC production is expected to grow by 80 percent to 54 million barrels per day in 2025, while non-OPEC production must rise 43 percent to 63.9 million barrels per day in 2025.¹⁶ However, this is easier said than done—the International Energy Agency estimates the expected expansion of production will require enormous investments in global oil infrastructure of \$3 trillion.¹⁷

UNREALISTIC, RISKY ALTERNATIVES TO THE MIDDLE EAST

Looking beyond OPEC to fill our needs offers no comfort—investment in new production wells continues to lag in non-OPEC countries, limiting any near-term growth in production.¹⁸ In short, the system has reached its limit. In May 2001 the Administration recognized the need for a new direction when it released its National Energy Policy but proposed a strategy that would only exacerbate the existing threats of petroleum dependence. The Administration proposes to avoid the Scylla of Middle East dependence by targeting the Charybdis of alternative oil-supplying nations for government investment and closer alliances, including Angola, Azerbaijan, Colombia, Kazakhstan, Mexico, Nigeria, Russia and Venezuela (see graph below). Yet the total proven reserves of these alternative oil suppliers, 198 billion barrels, is 70 percent lower than Persian Gulf reserves, and at current production levels offer only 30 more years of capacity.¹⁹ In comparison, the Persian Gulf has almost 100 years of proven reserves at 2003 production levels. Furthermore, all of the nations on the Administration's list face significant political and social instability and remain porous to global terrorism, making it difficult to attract the foreign investments necessary to finance future production.²⁰ Most importantly, increasing U.S. reliance on these states—many of which are unstable and undemocratic—would do little to address the security and economic threats of petroleum dependence.

While global market trends necessitate a new a direction for U.S. energy choices, shifting our imports to non-OPEC states is a risky, short-term solution at best. The Middle East holds most of the supply cards and looking elsewhere may well intensify the threats of dependence by continuing to expose the U.S. to the unpredictable political future and domestic tensions of oil supplying states.

¹²PFC Energy, *Global Crude Oil and Natural Gas Liquids Supply Forecast*, September 2004.

¹³Id. 2

¹⁴Mouawad, Jad, "Irrelevant? OPEC Is Sitting Pretty", *New York Times*, October 3, 2004.

¹⁵Energy Information Administration, *Annual Energy Outlook 2004*.

¹⁶Energy Information Administration, *Annual Energy Outlook 2004*, p.2-3.

¹⁷International Energy Agency, *World Energy Investment Outlook 2003*, Paris: IEA, 2003, Executive Summary, p. 29.

¹⁸Federal Reserve.

¹⁹British Petroleum, *Statistical Review of World Energy 2004*, <http://www.bp.com/genericarticle.do?categoryId=111&contentId=2004175>.

²⁰Klare, Michael T., *Blood and Oil: The Dangers and Consequences of America's Growing Dependence on Imported Petroleum*, Metropolitan Books, New York, New York, 2004.

DEPENDENCE ON OIL UNDERMINES U.S. ECONOMIC AND NATIONAL SECURITY

The high costs of oil have already been passed on to consumers through higher prices at the pump, more expensive goods and services, and a weaker job market and lower stock prices.²¹ In 2004 alone Americans spent roughly \$270 billion to feed our oil appetite, nearly half of last year's trade deficit.²² Sadly, this is just the latest chapter in the saga of oil dependence sapping our economy. Economist Philip Verleger finds that oil price spikes have cumulatively sapped 15 percent of our economy's growth, resulting in \$1.2 trillion in direct losses.²³ The total economic penalty of our oil dependence, including loss of jobs, output, and tax revenue is estimated to be \$297 to \$305 billion annually.²⁴ The most recent estimates suggest that during peacetime the U.S. spends an additional \$20 to \$40 billion per year in military costs to secure access to Middle East oil supplies (estimates predate current military operations in Iraq). At \$20 billion a year the American taxpayer is paying an additional \$4 to \$5 a barrel for crude oil beyond its market price.²⁵ And despite the already elevated oil prices, over the next 25 years the U.S. will also have to shoulder a substantial portion of the \$105 billion a year global investment necessary to finance additional oil production capacity.²⁶

Looking into the next few decades, the security costs and the risks of petroleum dependence will only increase as the global oil market tightens and geopolitical tensions play out in the arena of international trade. The International Energy Agency recently emphasized in its annual World Energy Outlook that current market trends suggest serious concerns for energy security and that the short-term risks to energy security will continue to grow as the flexibility of oil supply and demand diminishes, oil use becomes concentrated in the transportation sector in the absence of petroleum alternatives, and the growing oil demand is met by a small group of countries.²⁷ For example, today 26 million barrels of oil flow every day through just two critical choke points, the Straits of Hormuz in the Persian Gulf and the Straits of Malacca in Asia. By 2030 net inter-regional oil trade is expected to grow to 65 million barrels per day—over half of total oil production.²⁸ Traffic through these channels is expected to more than double over the next few decades—one of the many trends that will increase the vulnerability and security costs to oil-dependent nations.

In short, petroleum dependence imposes an incalculable price tag on American consumers and the U.S. economy, and is quickly becoming the Achilles heel of our national security.

TRUMPING INSECURITY WITH AMERICA'S STRONG SUIT: EFFICIENCY, INNOVATION

The real solution that Americans can count on for a healthy economy and greater national security is a lifeline of technology and efficient energy choices supplied by industries and workers here at home, not a lifeline of oil. *The U.S. must begin immediately to ease our intense oil addiction, first by making a national commitment to save 2.5 million barrels of oil per day by 2015.*

A key component of such a plan would increase the efficiency of cars and trucks, since the transportation sector will be responsible for 80% of the growth in oil demand through 2020. We did it before: Passenger car and light truck fuel efficiency increased 70 percent between 1975, when the fuel economy law was originally enacted, and its peak in 1987. Since then we've been moving backward. Overall mileage of our new cars and trucks has steadily dropped. Today it's at its lowest level in 20 years.

The reason is simple: While automotive engineering has advanced over the last decade to offer a wide variety of fuel-saving innovations, stagnant policies have fos-

²¹ Stone, Amey, "\$50 Oil: A Spreading Slick of Pain," *Business Week* 9/29/04.

²² Odessey, Bruce. "U.S. Trade Deficit Surges as Exports Fall, Oil Imports Rise", January 12, 2005. U.S. Consulate trade statistics, <http://www.hongkong.usconsulate.gov/usinfo/statis/ft/2004/11.htm>. Estimate calculated based on 2004 trade deficit data and EIA petroleum spending data in Id. 4.

²³ As quoted in Roberts, Paul, *The End of Oil: On the Edge of a Perilous New World*, Houghton Mifflin, New York, NY, 2004.

²⁴ National Defense Council Foundation. "The Hidden Cost of Imported Oil". September 2003, as cited by the Institute for the Analysis of Global Security, *Energy Security Bi-Weekly*, October 30, 2003.

²⁵ Jaffe, Amy Myers. United States and the Middle East: Policies and Dilemmas. Analysis commissioned by the National Commission on Energy Policy, www.energycommission.org.

²⁶ International Energy Agency. World Energy Outlook 2004, (119-121). Organization for Economic Cooperation and Development, 2004.

²⁷ *Ibid* (29)

²⁸ *Ibid* (32)

tered sluggish fuel economy and failed to harness technological potential to curb our massive oil demand. To re-energize policies, Congress must:

- provide automakers and their suppliers with incentives to retool factories to produce more efficient vehicles and create new jobs;
- raise fuel efficiency standards;
- expand the market for gasoline-electric hybrid vehicles through tax incentives;
- invest in alternative fuels, such as biofuels or hydrogen;
- encourage the adoption of fuel-efficient tires and motor oil in passenger vehicles;
- increase the efficiency of heavy-duty trucks and reduce idling; and
- provide transportation choices, such as public transit, that use significantly less oil per passenger.

However, this important national commitment requires contributions from sectors besides transportation. Specifically, the measures above can and should be complemented by:

- industrial efficiency techniques;
- fuel-savings steps in aviation management;
- reduced heating oil use in homes across America (for example, through weatherization).

NRDC believes that a healthy environment goes hand in hand with a healthy economy. We believe this country can continue to have strong economic growth and a high standard of living, while reducing our oil dependence and cutting global warming pollution. This can be achieved by investing in America, as called for by the bipartisan NCEP. Some of their recommendations mirror ours: \$3 billion in tax credits to manufacturers that build and to consumers who buy efficient vehicles, an increase in fuel-efficiency standards, and a national oil savings of at least 3 to 5 million barrels per day by 2025.

As a nation we must blaze a new path, one that will set the United States apart as an innovator and leader in efficiency, rather than a weak competitor and needy consumer of the world's energy. But steps won't be taken without leadership from Congress, and NRDC looks forward to working with Senators and staff to reduce dependence on oil and make our nation more secure through efficiency and innovation.

ROCKY MOUNTAIN INSTITUTE,
Snowmass, CO, February 2, 2005.

Hon. PETER DOMENICI,
Chairman, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.

Hon. JEFF BINGAMAN,
Ranking Member, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.

DEAR SENATORS DOMENICI AND BINGAMAN: As testimony to the record of the 10:00 a.m., 3 February 2005 Hearing on "Global energy trends and their potential impact on U.S. energy needs, security and policy," Rocky Mountain Institute hereby submits for the consideration of the U.S. Senate Committee on Energy and Natural Resources the Executive Summary and the Forewords (by George P. Shultz and Sir Mark Moody-Stuart) of our independent, peer-reviewed, Pentagon-cosponsored analysis entitled *Winning the Oil Endgame*, published 20 September 2004. Our study details how to eliminate U.S. oil dependence over the next few decades, and revitalize the economy, led by business, for profit. Please permit us to highlight four key implications:

- The most important energy choices before the U.S. are not about which *energy* forecast or policy to adopt, but rather about *industrial and technological* strategy. Will America import efficient cars to displace foreign oil, or *make* efficient cars to displace both foreign oil and foreign cars? China's energy policy focuses on major efficiency improvements and leapfrog technologies, linked with her industrial policy to become a major exporter of [efficient] cars, so America's lack of such strategies puts the Big Three at risk. In contrast, we believe Boeing's bet on efficiency with the *787 Dreamliner* will prove a winning strategy in its rivalry with Airbus.
- EIA's 2004 forecast implies that *the U.S. will use approximately 100% more oil in the long run than we found is cost-effective for providing the assumed services*. That is, compared with EIA's January 2004 Reference Case, our analysis

showed how to save half of the United States' forecast 2025 oil use at an average cost of \$12 per barrel of crude oil (2000 \$), and how to displace the other half with robustly competitive supply-side substitutions, while delivering the same services that underlie the EIA forecast. This would save the U.S. \$70 billion per year net from avoided fuel costs (at EIA's 2025 forecast price of \$26/bbl in 2000 \$). Biofuels production in the Midwest would boost rural incomes by \$40 billion per year. A million net new jobs would be created and a million more retained.

- Why can't EIA's forecasting methodology—conventional, capably applied, and useful for reference—reveal such fundamental opportunities? Why can't EIA's forecast come close to defining the limits of profitable choice? EIA's slate of technologies for both end-use efficiency and supply-side substitutions doesn't reflect the current state of the shelf in cost or performance. EIA forecasts only 5% of new light vehicles are hybrids by 2025, and they're far less efficient than today's market offerings. Yet we found that under a slightly different policy scenario, 77% could be far more efficient than today's hybrids, and cost no more. This matters a lot. If, for illustration, all new light vehicles in 2025 were only as efficient as today's best-on-the-market hybrids, total U.S. oil consumption would be one-sixth lower than in EIA's 2004 Reference Case—equivalent to saving twice today's net oil imports from the Persian Gulf.
- EIA's *Annual Energy Outlook* models business-as-usual with minor variations. It only shows what might happen if policies and business strategies didn't change. Thus *AEO* is not fate; it is not a mandate that one must fulfill; and it absolutely does not illuminate the true range of national choice. Rather than striving to meet current EIA forecasts, policymakers need to choose national goals and ask EIA to model the full range of ways to achieve them. This requires a different modeling methodology. Changes in EIA's current model are driven only by shifts in relative prices or in enacted public-policy mandates. Yet, as our study showed, the biggest shifts in energy patterns can come from private-sector innovation driven by competitive strategy—by the kinds of business models we analyzed for the car, truck, plane, and oil industries. EIA should be permitted and encouraged to model these business drivers to develop meaningful policy paths and outcomes. Policymakers should appreciate that those drivers may be more important than prices or public policies, so lighthanded policies tailored to support these business drivers may be more attractive and effective than fuel taxes, subsidies, and mandates. Our study proposed just such an innovative approach, and EIA's modeling mandate should be extended to illuminate those kinds of drivers and outcomes.

Our full analysis and its technical backup, including all models, spreadsheets, documentation, reviews, and commentaries, are posted for free download at www.oilendgame.com. We hope they will inform the Committee's deliberations.

Sincerely,

AMORY B. LOVINS,
CEO.

[Enclosures.]

WINNING THE OIL ENDGAME
INNOVATION FOR PROFITS, JOBS, AND SECURITY

EXECUTIVE SUMMARY

Winning the Oil Endgame offers a coherent strategy for ending oil dependence, starting with the United States but applicable worldwide. There are many analyses of the oil problem. This synthesis is the first roadmap of the oil *solution*—one led by business for profit, not dictated by government for reasons of ideology. This roadmap is independent, peer-reviewed, written for business and military leaders, and co-funded by the Pentagon. It combines innovative technologies and new business models with uncommon public policies: market-oriented without taxes, innovation-driven without mandates, not dependent on major (if any) national legislation, and designed to support, not distort, business logic.

Two centuries ago, the first industrial revolution made people a hundred times more productive, harnessed fossil energy for transport and production, and nurtured the young U.S. economy. Then, over the past 145 years, the Age of Oil brought unprecedented mobility, globe-spanning military power, and amazing synthetic products.

But at what cost? Oil, which created the sinews of our strength, is now becoming an even greater source of weakness: its volatile price erodes prosperity; its vulnerabilities undermine security; its emissions destabilize climate. Moreover the

quest to attain oil creates dangerous new rivalries and tarnishes America's moral standing. All these costs are rising. And their root causes—most of all, inefficient light trucks and cars—also threaten the competitiveness of U.S. automaking and other key industrial sectors.

The cornerstone of the next industrial revolution is therefore winning the Oil Endgame. And surprisingly, it will cost *less* to displace all of the oil that the United States now uses than it will cost to *buy* that oil. Oil's current market price leaves out its true costs to the economy, national security, and the environment. But even without including these now "externalized" costs, it would still be profitable to displace oil completely over the next few decades. In fact, by 2025, the *annual* economic benefit of that displacement would be \$130 billion gross (or \$70 billion net of the displacement's costs). To achieve this does not require a revolution, but merely consolidating and accelerating trends already in place: the amount of oil the economy uses for each dollar of GDP produced, and the fuel efficiency of light vehicles, would need only to improve about three-fifths as quickly as they did in response to previous oil shocks.

Saving half the oil America uses, and substituting cheaper alternatives for the other half, requires four integrated steps:

- *Double the efficiency of using oil.* The U.S. today wrings twice as much work from *each* barrel of oil as it did in 1975; with the latest proven efficiency technologies, it can double oil efficiency all over again. The investments needed to save each barrel of oil will cost only \$12 (in 2000 \$), less than half the officially forecast \$26 price of that barrel in the world oil market. The most important enabling technology is ultralight vehicle design. Advanced composite or light-weight-steel materials can nearly double the efficiency of today's popular hybrid-electric cars and light trucks while improving safety and performance. The vehicle's total extra cost is repaid from fuel savings in about three years; the ultralighting is approximately free. Through emerging manufacturing techniques, such vehicles are becoming practical and profitable; the factories to produce them will also be cheaper and smaller.
- *Apply creative business models and public policies* to speed the profitable adoption of superefficient light vehicles, heavy trucks, and airplanes. Combined with more efficient buildings and factories, these efficient vehicles can cut the official forecast of oil use by 29% in 2025 and another 23% soon thereafter—52% in all. Enabled by a new industrial cluster focusing on lightweight materials, such as carbon-fiber composites, such advanced-technology vehicles can revitalize these three strategic sectors and create important new industries.
- *Provide another one-fourth of U.S. oil needs by a major domestic biofuels industry.* Recent advances in biotechnology and cellulose-to-ethanol conversion can double previous techniques' yield, yet cost less in both capital and energy. Replacing fossil-fuel hydrocarbons with plant-derived carbohydrates will strengthen rural America, boost net farm income by tens of billions of dollars a year, and create more than 750,000 new jobs. Convergence between the energy, chemical, and agricultural value chains will also let versatile new classes of biomaterials replace petrochemicals.
- Use well established, highly profitable efficiency techniques to *save half the projected 2025 use of natural gas*, making it again abundant and affordable, then substitute part of the saved gas for oil. If desired, the leftover saved natural gas could be used even more profitably and effectively by converting it to hydrogen, displacing most of the remaining oil use—and all of the oil use if modestly augmented by competitive renewable energy.

These four shifts are fundamentally disruptive to current business models. They are what economist Joseph Schumpeter called "creative destruction," where innovations destroy obsolete technologies, only to be overthrown in turn by ever newer, more efficient rivals. In *The Innovator's Dilemma*, Harvard Business School professor Clayton Christensen explained why industry leaders often get blindsided by disruptive innovations—technological gamechangers—because they focus too much on today's most profitable customers and businesses, ignoring the needs of the future. Firms that are quick to adopt innovative technologies and business models will be the winners of the 21st century; those that deny and resist change will join the dead from the last millennium. In the 108-year history of the Dow Jones Industrial Average, only one of 12 original companies remains a corporate entity today—General Electric. The others perished or became fodder for their competitors.

What policies are needed? American companies can be among the quick leaders in the 21st century, but it will take a cohesive strategy-based transformation, bold business and military leadership, and supportive government policies at a federal

or at least a state level. *Winning the Oil Endgame* charts these practical steppingstones to an oil-free America:

- Most importantly, revenue-and size-neutral “feebates” can shift customer choice by combining fees on inefficient vehicles with rebates to efficient vehicles. The feebates apply separately within each vehicle-size class, so freedom of choice is unaffected. Indeed, choice is enhanced as customers start to count fuel savings over the vehicle’s life, not just the first few years, and this new pattern of demand pulls super-efficient but uncompromised vehicles from the drawing-board into the showroom.
- A scrap-and-replace program can lease or sell super-efficient cars to low-income Americans—on terms and with fuel bills they can afford—while scrapping clunkers. This makes personal mobility affordable to all, creates a new million-car-a-year market for the new efficiency technologies, and helps clean our cities’ air.
- Military needs for agility, rapid deployment, and streamlined logistics can drive Pentagon leadership in developing key technologies.
- Implementing smart government procurement and targeted technology acquisition (the “Golden Carrot”) for aggregated buyers will accelerate manufacturers’ conversion, while a government-sponsored \$1-billion prize for success in the marketplace, the “Platinum Carrot,” will speed development of even more advanced vehicles.
- To support U.S. automakers’ and suppliers’ need to invest about \$70 billion to make advanced technology vehicles, federal loan guarantees can help finance initial retooling where needed; the investments should earn a handsome return, with big spin-off benefits.
- Similar but simpler policies—loan guarantees for buying efficient new airplanes (while scrapping inefficient parked ones), and better information for heavy truck buyers to spur market demand for doubled-efficiency trucks—can speed these oil-saving innovations from concept to market.
- Other policies can hasten competitive evolution of next-generation biofuels and biomaterials industries, substituting durable revenues for dwindling agricultural subsidies, and encouraging practices that protect both topsoil and climate.

What happens to the oil industry? The transition beyond oil is already starting to transform oil companies like Shell and BP into energy companies. Done right, this shift can profitably redeploy their skills and assets rather than lose market share. Biofuels are already becoming a new product line that leverages existing retail and distribution infrastructure and can attract another \$90 billion in biofuels and bio-refining investments. By following this roadmap, the U.S. would set the stage by 2025 for the checkmate move in the Oil Endgame—the optional but advantageous transition to a hydrogen economy and the complete and permanent displacement of oil as a direct fuel. Oil may, however, retain or even gain value as one of the competing sources of hydrogen.

How big is the prize? Investing \$180 billion over the next decade to eliminate oil dependence and revitalize strategic industries can save \$130 billion gross, or \$70 billion net, every year by 2025. This saving, equivalent to a large tax cut, can replace today’s \$10-billion-a-month oil imports with reinvestments in ourselves: \$40 billion would pay farmers for biofuels, while the rest could return to our communities, businesses, and children. Several million automotive and other transportation-equipment jobs now at risk can be saved, and one million net new jobs can be added across all sectors. U.S. automotive, trucking, and aircraft production can again lead the world, underpinned by 21st century advanced-materials and fuel-cell industries. A more efficient and deployable military could refocus on its core mission—protecting American citizens rather than foreign supply lines—while supporting and deploying the innovations that eliminate oil as a cause of conflict. Carbon dioxide emissions will shrink by one-fourth with no additional cost or effort. The rich-poor divide can be drastically narrowed at home by increased access to affordable personal mobility, shrinking the welfare rolls, and abroad by leapfrogging over oil-dependent development patterns. The U.S. could treat oil-rich countries the same as countries with no oil. Being no longer suspected of seeking oil in all that it does in the world would help to restore U.S. moral leadership and clarity of purpose.

While the \$180-billion investment needed is significant, the United States’ economy already pays that much, with zero return, every time the oil price spikes up as it has done in 2004. (And that money goes into OPEC’s coffers instead of building infrastructure at home.) Just by 2015, the early steps in this proposed transition will have saved as much oil as the U.S. gets from the Persian Gulf. By 2040, oil imports could be gone. By 2050, the U.S. economy should be flourishing with no oil at all.

How do we get started? Every sector of society can contribute to this national project. Astute business leaders will align their corporate strategies and reorganize their firms and processes to turn innovation from a threat to a friend. Military leaders will speed military transformation by promptly laying its foundation in super-efficient platforms and lean logistics. Political leaders will craft policies that stimulate demand for efficient vehicles, reduce R&D and manufacturing investment risks, support the creation of secure domestic fuel supplies, and eliminate perverse subsidies and regulatory obstacles. Lastly, we, the people, must play a role—a big role—because our individual choices guide the markets, enforce accountability, and create social innovation.

Our energy future is choice, not fate. Oil dependence is a problem we need no longer have—and it's cheaper not to. U.S. oil dependence can be eliminated by proven and attractive technologies that create wealth, enhance choice, and strengthen common security. This could be achieved only about as far in the future as the 1973 Arab oil embargo is in the past. When the U.S. last paid attention to oil, in 1977-85, it cut its oil use 17% while GDP grew 27%. Oil imports fell 50%, and imports from the Persian Gulf by 87%, in just eight years. That exercise of dominant market power—from the demand side—broke OPEC's ability to set world oil prices for a decade. Today we can rerun that play, only better. The obstacles are less important than the opportunities if we replace ignorance with insight, inattention with foresight, and inaction with mobilization. American business can lead the nation and the world into the post-petroleum era, a vibrant economy, and lasting security—if we just realize that we are the people we have been waiting for.

Together we can end oil dependence forever.

QUOTATIONS ABOUT WINNING THE OIL ENDGAME

"This exciting synthesis of how to eliminate America's oil dependence could be the most important step in many years toward secure and affordable energy. Its novel but persuasive ideas, which hold promise of revitalizing American industry and agriculture, should appeal to conservatives and liberals alike."

President Jimmy Carter

"We can, as Amory Lovins and his colleagues show vividly, win the oil endgame. . . . [A]n intriguing case that is important enough to merit careful attention by all of us, private citizens and business and political leaders alike."

George P. Shultz, Distinguished Fellow at the Hoover Institution, Stanford University; former Secretary of State, the Treasury, and Labor

"[T]his compelling synthesis . . . demonstrates that innovative technologies can achieve spectacular [oil] savings . . . with no loss of utility, convenience and function. It makes the business case for how a profitable transition for the automotive, truck, aviation, and oil sectors can be achieved. . . . The refreshingly creative government policies suggested . . . merit serious attention, . . . and I suspect they could win support across the political spectrum. . . . This report will help to launch, inspire, and inform a new and necessary conversation about energy and security, economy and environment. Its outcome is vital for us all."

Sir Mark Moody-Stuart, Chairman, Anglo American plc;
former Chairman, Royal Dutch/Shell Group

"Amory Lovins has had more impact on our energy use than any single person in the world. Now his team has produced one of the most important energy studies in decades. It merits careful examination as a profitable strategy for achieving energy security, economic prosperity, and environmental quality through smart business strategies accelerated by efficient government policy."

William Martin, Chairman, Council on Foreign Relations,
Energy Security Group

"One of the best analyses of energy policy yet produced."

Time magazine

For the full report and more information, please visit www.oilendgame.com.

FOREWORD TO WINNING THE OIL ENDGAME BY GEORGE P. SCHULTZ

Crude prices are rising, uncertainty about developments in the Middle East roils markets and, well, as Ronald Reagan might say, "Here we go again." Once more we face the vulnerability of our oil supply to political disturbances. Three times in the past thirty years (1973, 1978, and 1990) oil price spikes caused by Middle East crises helped throw the U.S. economy into recession. Coincident disruption in Venezuela and Russia adds to unease, let alone prices, in 2004. And the surging economies of China and India are contributing significantly to demand. But the problem

far transcends economics and involves our national security. How many more times must we be hit on the head by a two-by-four before we do something decisive about this acute problem?

In 1969, when I was Secretary of Labor, President Nixon made me the chairman of a cabinet task force to examine the oil import quota system, in place since 1954. Back then, President Eisenhower considered too much dependence on imported oil to be a threat to national security. He thought anything over 20 percent was a real problem. No doubt he was nudged by his friends in the Texas and Louisiana oil patches, but Ike was no stranger to issues of national security and foreign policy.

The task force was not prescient or unanimous but, smelling trouble, the majority could see that imports would rise and they recommended a new monitoring system to keep track of the many uncertainties we could see ahead, and a new system for regulating imports. Advocates for even greater restrictions on imports argued that low-cost oil from the Middle East would flood our market if not restricted.

By now, the quota argument has been stood on its head as imports make up an increasing majority, now almost 60 percent and heading higher, of the oil we consume. And we worry not about issues of letting imports in but that they might be cut off. Nevertheless, the point about the importance of relative cost is as pertinent today as back then and applies to the competitive pressures on any alternative to oil. And the low-cost producers of oil are almost all in the Middle East.

That is an area where the population is exploding out of control, where youth is by far the largest group, and where these young people have little or nothing to do. The reason is that governance in these areas has failed them. In many countries, oil has produced wealth without the effort that connects people to reality, a problem reinforced in some of them by the fact that the hard physical work is often done by imported labor. The submissive role forced on women has led to this population explosion. A disproportionate share of the world's many violent conflicts is in this area. So the Middle East remains one of the most unstable parts of the world. Only a dedicated optimist could believe that this assessment will change sharply in the near future. What would be the impact on the world economy of terrorist sabotage of key elements of the Saudi pipeline infrastructure?

I believe that, three decades after the Nixon task force effort, it is long past time to take serious steps to alter this picture dramatically. Yes, important progress has been made, with each administration announcing initiatives to move us away from oil. Advances in technology and switches from oil to natural gas and coal have caused our oil use per dollar of GDP to fall in half since 1973. That helps reduce the potential damage from supply problems. But potential damage is increased by the rise of imports from 28 percent to almost 60 percent of all the oil we use. The big growth sector is transportation, up by 50 percent. Present trends are unfavorable; if continued, they mean that we are likely to consume—and import—several million barrels a day more by 2010.

Beyond U.S. consumption, supply and demand in the world's oil market has become tight again, leading to many new possibilities of soaring oil prices and massive macroeconomic losses from oil disruptions. We also have environmental problems to concern us. And, most significantly, our national security and its supporting diplomacy are left vulnerable to fears of major disruptions in the market for oil, let alone the reality of sharp price spikes. These costs are not reflected in the market price of oil, but they are substantial.

What more can we do? Lots, if we are ready for a real effort. I remember when, as Secretary of the Treasury, I reviewed proposals for alternatives to oil from the time of the first big oil crisis in 1973. Pie in the sky, I thought. But now the situation is different. We can, as Amory Lovins and his colleagues show vividly, win the oil endgame. How do we go about this?

A baseball analogy may be applicable. Fans often have the image in their minds of a big hitter coming up with the bases loaded, two outs, and the home team three runs behind. The big hitter wins the game with a home run. We are addicted to home runs, but the outcome of a baseball game is usually determined by a combination of walks, stolen bases, errors, hit batsmen, and, yes, some doubles, triples, and home runs. There's also good pitching and solid fielding, so ball games are won by a wide array of events, each contributing to the result. Lovins and his coauthors show us that the same approach can work in winning the oil endgame. There are some potential big hits here, but the big point is that there are a great variety of measures that can be taken that each will contribute to the end result. The point is to muster the will power and drive to pursue these possibilities.

How do we bring that about? Let's not wait for a catastrophe to do the job. Competitive information is key. Our marketplace is finely tuned to the desire of the consumer to have real choices. We live in a real information age, so producers have to be ready for the competition that can come out of nowhere. Lovins and his col-

leagues provide a huge amount of information about potential competitive approaches. There are home run balls here, the ultimate one being the hydrogen economy. But we don't have to wait for the arrival of that day. There are many things that can be done now, and this book is full of them. Hybrid technology is on the road and currently increases gas mileage by 50 percent or more. The technology is scaleable. This report suggests many ways to reduce weight and drag, thereby improving performance. A big point in this report is evidence that new, ultralight-but-safe materials can nearly redouble fuel economy at little or no extra cost.

Sequestration of effluent from use of coal may be possible on an economic and comfortable basis, making coal a potentially benign source of hydrogen. Maybe hydrogen could be economically split out of water by electrolysis, perhaps using renewables such as windpower; or it could certainly be made, as nearly all of it is now, by natural gas saved from currently wasteful practices, an intriguingly lucrative option often overlooked in discussions of today's gas shortages. An economy with a major hydrogen component would do wonders for both our security and our environment. With evident improvements in fuel cells, that combination could amount to a very big deal. Applications include stationary as well as mobile possibilities, and other ideas are in the air. Real progress has been made in the use of solar systems for heat and electricity. Scientists, technologists, and commercial organizations in many countries are hard at work on these issues.

Sometimes the best way to get points across is to be provocative, to be a bull in a china closet. Amory Lovins loves to be a bull in a china closet—anybody's china closet. With this book, the china closet he's bursting into is ours and we should welcome him because he is showing us how to put the closet back together again in far more satisfactory form. In fact, Lovins and his team make an intriguing case that is important enough to merit careful attention by all of us, private citizens and business and political leaders alike.

FOREWORD TO WINNING THE OIL ENDGAME BY SIR MARK MOODY-STUART

In this compelling synthesis, Amory Lovins and his colleagues at Rocky Mountain Institute provide a clear and penetrating view of one of the critical challenges facing the world today: the use of energy, especially oil, in transportation, industry, buildings, and the military. This report demonstrates that innovative technologies can achieve spectacular savings in all of these areas with no loss of utility, convenience and function. It makes the business case for how a profitable transition for the automotive, truck, aviation, and oil sectors can be achieved, and why they should embrace technological innovation rather than be destroyed by it. We are not short of energy in this world of ours; we have large resources of the convenient hydrocarbons on which our economies are based, and even greater resources of the coal on which our economies were originally built. But there are two serious issues relating to its supply and use.

First, some three fourths of the reserves sit in a few countries of the Middle East, subject to actual and potential political turmoil. Second, there are the long-term climatic effects of the burning of increasing amounts of fossil fuels. While the normal rate of change of technology is likely to mean that we will be on one of the lower impact scenarios of climate change and not at the apocalyptic end favoured by doom mongers, it is reasonably certain that our world will have to adapt to significant climate change over the next century. These two factors mean that, unless there is a change of approach, the United States will inexorably become increasingly dependent on imported energy—be it oil or natural gas. At the same time, on the international scene, the United States will be criticised by the rest of the world for profligate use of energy, albeit to fuel an economy on whose dynamism and success the rest of the world is also manifestly dependent. Furthermore, thoughtful people wonder what we will do if the booming economies and creative people of China and India have energy demands which are on the same development curve as the United States.

The RMI team has approached this economic and strategic dilemma with technical rigour, good humour, and common sense, while addressing two key requirements often overlooked by energy policy advocates.

First, we have to deliver the utility, reliability and convenience that the consumer has come to expect. As business people we recognise this. It is no good expecting people in the United States to suddenly drive smaller, less convenient or less safe vehicles. We have to supply the same comfort and utility at radically increased levels of energy efficiency. Most consumers, who are also voters, have only a limited philosophical interest in energy efficiency, security of supply, and climate change. Most of us have a very intense interest in personal convenience and safety—we expect governments and business to handle those other issues on our behalf. There

is a very small market in this world for hair shirts. Similarly, we cannot expect the citizens of China and India to continue to ride bicycles in the interests of the global environment. They have exactly the same aspirations to comfort and convenience as we do. This book demonstrates how by applying existing technologies to lightweight vehicles with the use of composites, by the use of hybrid powertrains already in production, and with the rapid evolution to new technologies, we can deliver the high levels of convenience and reliability we are used to at radically increased levels of energy efficiency, while also maintaining cost efficiency.

The second critical requirement is that the process of transition should be fundamentally economic. We know in business that while one may be prepared to make limited pathfinding investments at nil or low return in order to develop new products and markets, this can not be done at a larger scale, nor indefinitely. What we can do, and have seen done repeatedly, is to transform markets by delivering greater utility at the same cost or the same utility at a lower cost, often by combining more advanced technologies with better business models. When this happens, the rate of change of markets normally exceeds our wildest forecasts and within a space of a few years a whole new technology has evolved.

A good example of the rapid development and waning of technology is the fax machine. With astonishing rapidity, because of its functional advantages over surface mail, the fax machine became globally ubiquitous. The smallest businesses around the world had one and so did numerous homes. The fax has now become almost obsolete because of e-mail, the email attachment and finally the scanned e-mail attachment. The connectivity of the Internet, of which e-mail is an example, has transformed the way we do business. What this book shows is that the delivery of radically more energy-efficient technologies has dramatic cost implications and therefore has the potential for a similarly economically driven transition.

The refreshingly creative government policies suggested here to smooth and speed that transition are a welcome departure from traditional approaches that often overlook or even reject the scope of enterprise to be an important part of the solution. These innovative policies, too, merit serious attention, especially as an integrated package, and I suspect they could win support across the political spectrum.

The technological, let alone policy, revolution has not been quick in coming to the United States. Yet as has happened before in the automobile industry, others are aware of the potential of the technology. Perhaps because of Japan's obsession with energy security, Toyota and Honda began some years ago to hone the electric-hybrid technology that is likely to be an important part of the energy efficiency revolution. As a result, U.S. automobile manufacturers who now see the market opportunities of these technologies are turning to the proven Japanese technology to deliver it rapidly.

I believe that we may see a similar leapfrogging of technology from China. China is fully aware of the consequences on energy demand, energy imports, and security of supply of its impressive economic growth. Already China is using regulation to channel development into more energy-efficient forms. The burgeoning Chinese automobile industry is likely to be guided down this route—delivering the function and convenience, but at greatly increased levels of efficiency. And it is not just in the automobile industry—by clearly stated national policy it applies to all areas of industrial activity. This has great implications both for the participation by U.S. firms in investment in China, and also in the impact of future Chinese manufactures on a global market that is likely to be paying much greater attention to energy efficiency.

As a businessman, I am attracted by the commercial logic and keen insight that this report brings to the marketplace struggle between oil and its formidable competitors on both the demand and the supply sides. Indeed, during my time in both Shell and Anglo American, RMI's engineers have helped ours to confirm unexpectedly rich deposits of mineable "negawatts" and "negabarrels" in our own operations—an exploration effort we're keen to intensify to the benefit of both our shareholders and the environment.

As a lifelong oil man and exploration geologist, I am especially excited to learn about the Saudi Arabia-size riches that Amory Lovins and RMI's explorers have discovered in what they term the Detroit Formation—through breakthrough vehicle design that can save vast amounts of oil more cheaply than it can be supplied. And as a citizen and grandparent, I am pleased that RMI proposes new business models to span the mobility divide that separates rich and poor, not just in the United States, but in many places in the world. Concern about such opportunity divides is increasingly at the core not just of international morality but also of stability and peace.

This book points the way to an economically driven energy transformation. And its subtitle "Innovation for Profit, Jobs, and Security" is both a prospectus for posi-

tive change and a reminder that both the United States and other countries can be rapid adapters of innovative technologies, with equally transformative economic consequences. As someone who has spent a lifetime involved in energy and changes in energy patterns, I find the choice an easy one to make. The global economy is very much dependent on the health of the U.S. economy, so I hope that the U.S. indeed makes the right choice.

This report will help to launch, inspire, and inform a new and necessary conversation about energy and security, economy and environment.

Its outcome is vital for us all.

STATEMENT OF DAVID J. O'REILLY, CHAIRMAN AND CHIEF EXECUTIVE OFFICER,
CHEVRONTEXACO CORP.

PUBLISHED NOVEMBER 28, 2004, IN THE WASHINGTON TIMES

The late economist Herbert Stein once said, if something cannot go on forever, it will stop. The time when we could count on cheap, abundant oil is clearly approaching that point. Prices are not likely to stay in the \$50 range as they have in recent months. But it is even more unlikely they will retreat to late 20th-century levels as low as \$10 a barrel.

The reasons are complex, but it is critical we understand them so we can move to drive volatility out of the energy markets and replace it with predictability and stability, two prerequisites for sustained economic growth.

A basic reason for price volatility is surging demand. China alone accounted for roughly 30 percent of this year's total growth in world oil demand. Global energy demand is expected to jump 40 percent over the next two decades. It took the world 125 years to consume the first trillion barrels of oil. We'll consume the next trillion within 35 years.

But demand is not the only factor. Supply is also an issue.

Simply put, the age of easy oil and gas is over, partly because we are seeing the convergence of geological difficulty with geopolitical instability and hard-to-reach supply with rising demand. In essence, we face a new energy equation.

Many of the world's large oil fields outside the Organization of Petroleum Exporting Countries are maturing just as demand is growing. Increasingly, future supplies must be found in areas more difficult to access and develop, such as ultra-deep water and oil sands. Developing these new frontiers will require trillions of dollars of investment in new infrastructure and innovative technology. And the world oil increasingly comes from areas with stability concerns, such as the Middle East.

As the Bush administration heads into its second term, we need to recognize this new equation's realities and align our policies and actions to address them. Here are four pragmatic steps we can take in the short-term to do that.

(1) We should maximize the value of the resources we have now, on both the supply and the demand side. Simply put, over the next 20 years we will need all the energy we can develop. We should allow access for responsible development of promising resource regions in the Arctic, the Rocky Mountains and offshore. In resource-rich countries in the developing world, we should promote enhanced contract sanctity and transparency, which will encourage more investment and access, while helping expand the economic and social benefits of oil production for local communities. At the same time, we need to moderate demand by pushing for more energy efficiency in everything from consumer appliances to automobiles and aircraft. In the near-term, conservation is our easiest, cheapest and most reliable "new" energy source.

(2) We need to create a regulatory climate that encourages energy production. In the U.S., some key operating rules should be revised for refineries, now operating at virtually full capacity. If the government streamlines the permit process, industry can proceed to add capacity or improve efficiency without increasing emissions. We should rationalize state and regional gasoline standards that have effectively "balkanized" gasoline supplies. We now have 18 different gasoline blends in the U.S. to comply with these standards, making it difficult to move supplies around the country to even out supply disruptions and moderate pump prices. Natural gas, clean-burning and plentiful globally but in tight supply in the United States, needs to be commercialized sensibly but aggressively. The United States has only four terminals capable of receiving liquefied natural gas, while most forecasts estimate a need for 10 to 14 new import terminals by 2015 to meet projected demand.

(3) We should increase investments in viable alternative energy sources for the future. Renewable sources like solar, wind and water will continue playing a greater role, growing to about 7 percent of our total energy needs by the year 2020. We need

to continue investing in renewables and, at the same time, invest in understanding the potential of new alternative sources such as hydrogen. Although hydrogen's viability as a widely used fuel is years away, investment today will help assess its practicality and potentially accelerate its commercial viability.

(4) The U.S. business community must recognize energy as a strategic—and global—business issue. Corporate America can no longer treat energy as an expense item or solely as a domestic issue. It is time for business to act on the knowledge that access to sufficient, predictable energy supplies is a strategic issue for every company in every sector of the U.S. economy. The business community should educate the public about the indelible link between reliable energy and economic growth, while helping policymakers draft a comprehensive national energy policy to let us balance volatility with stability and increasing consumption with greater efficiency.

Moreover, U.S. energy policy in the 21st century cannot stop at the water's edge. It must reflect our interdependence with producing countries and encourage bilateral relationships that recognize the importance of energy development and promote the flow of capital and investment.

Sensible, pragmatic development of new energy supplies is not just a business issue. Energy development is ultimately a fundamental element of human progress, particularly in the developing world whose population is expected to grow more than 1.5 billion in the next 15 to 20 years. Access to energy, like employment and education, is a building block of stable and prosperous societies. It is our collective responsibility to provide that access.

The end of easy energy may mean the end of easy choices. But recognizing the new energy equation is a strong first step toward resolving it in our favor.

