

ENERGY AND OIL MARKET OUTLOOK

HEARING
BEFORE THE
COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE
ONE HUNDRED TWELFTH CONGRESS
FIRST SESSION
TO
RECEIVE TESTIMONY ON THE ENERGY AND OIL MARKET OUTLOOK
FOR THE 112TH CONGRESS

FEBRUARY 3, 2011



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ENERGY AND OIL MARKET OUTLOOK

THURSDAY, FEBRUARY 3, 2011

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

The committee met, pursuant to notice, at 9:33 a.m., in room SH-216, Hart Senate Office Building, Hon. Jeff Bingaman, chairman, presiding.

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

The CHAIRMAN. Why don't we go ahead and get started?

Senator Murkowski is on her way here but was stuck in traffic and asked that we proceed without her.

Let me first just mention, welcome to the committee. We have eight new members of this committee in this Congress, and one or two of them have come to the earlier hearings we had, but I hope several will come to this hearing. Let me just mention who they are and welcome them all—Senator Franken, who is here; Senator Coons; Senator Manchin; Senator Portman; Senator Lee, welcome to the committee; Senator Coats; Senator Paul; and Senator Hoeven. So we are glad to have them all on the committee and look forward to working with them.

Let me go through a short statement here, and then we will begin our testimony.

This is an oversight hearing on the energy and oil market outlook for this 112th Congress. As many of you know, we usually try to start each new Congress by having a sort of scene-setting hearing of this kind, which will look at the broad energy trends that we expect to influence our thoughts on energy policy, also more specifically on agenda items that come before the committee during this 2-year Congress.

Today, we will start that discussion by hearing from Dr. Richard Newell, who is the Administrator of the Department of Energy's Energy Information Administration. He is going to give us highlights of EIA's latest short-and long-term energy market forecasts. We appreciate him being here. He just returned from a trip to the Middle East, I understand, and perhaps he can give us some insights from that trip.

The committee is a heavy consumer of EIA information and products. So we always appreciate having EIA share its data and its analyses with us.

We also will hear from Ambassador Jones, who is the Deputy Director of the International Energy Agency in Paris. We look for-

ward to discussing IEA's forecast of total world energy supply and demand out through 2035. I would also note that IEA was founded as a forum for responding to oil supply disruptions, and it still has an important role to play in that capacity.

Executive Director Tanaka, who was scheduled to be with us, found that the current situation in the Middle East required him to remain at their headquarters in Paris, but we are in good hands with Ambassador Jones, whose impressive resume includes service as the U.S. Ambassador in many of the countries in the Middle East. Given the current situation that we are seeing internationally, we are especially grateful to him for being here to give us the International Energy Agency perspective.

We are also pleased to have two other very impressive witnesses with us, leading experts on energy, both of whom are familiar to the committee. They testified in 2008, as we attempted to understand that year's historic oil price spike. Mr. Diwan is partner and head of financial advisory with PFC Energy in Washington, and Mr. Jim Burkhard is the managing director of Cambridge Energy Research Associates in Cambridge, Massachusetts. So we very much appreciate them being here.

Since the hearing was announced early last week, I think it is safe to say that members and witnesses alike have been following the developments in the Middle East with much interest. Fortunately, it appears unlikely that the political turmoil will result in major disruptions in oil production or transportation. At least at this time, that is my impression.

However, I note that whenever geopolitical events of this type occur, it reminds us of our vulnerability to world oil supply disruptions, and it is a spur for us to consider energy policies that help to reduce that vulnerability.

That is why I am particularly glad to see that EIA is forecasting a decline in U.S. consumption of imported oil between now and 2035. Until very recently, reversing the decade-old narrative of ever-increasing U.S. dependence on foreign oil seemed all but impossible. We now see that 2005 might well have been the high-water mark in U.S. oil import dependence.

Increased vehicle efficiency, a transition to increased reliance on biofuels, together with gains in U.S. oil production—all of those are creating real national and economic security benefits. I am optimistic that further technology advances, both in vehicles and in fuels, could make us even less reliant on imported oil than the current forecast predicts. I hope that we in the Congress will have the good sense to remain on this path toward increased energy independence.

Now, with that, let me stop and defer to Senator Murkowski for any comments she would like to make before we hear from the witnesses.

**STATEMENT OF HON. LISA MURKOWSKI, U.S. SENATOR
FROM ALASKA**

Senator MURKOWSKI. Thank you and good morning, Mr. Chairman.

I was eager to hold this hearing even before the unrest that we are seeing in Tunisia and Egypt and how this has grown into the

international crisis that we are now witnessing. We say this a lot in this committee, but I think today's hearing is particularly timely.

While we have seen no interruption in the supply of oil, the unrest in North Africa is affecting its price, and that should help us understand the costs and the consequences that are associated with our current energy policy.

I think there is strong bipartisan agreement that our Nation is far too dependent on foreign oil, and I have always found it unfortunate that agreement seems to end there for so many members. I have never been one to deny the critical need for greater energy efficiency, for greater investments in alternatives, and for a responsible path forward for a cleaner energy future. This is and will continue to be a major undertaking, and the written testimony that we have today reflects that efficiency, biofuels, and other technologies will make an important contribution in the coming decades. I think that is a good thing, and we will continue to build on it here in this committee.

But I am also quite interested in what we can achieve today, not just tomorrow. Despite the unfortunate state of our economy, oil prices are near \$100 per barrel, and hardly anyone expects a correction back to \$50 or even \$80. Instead, oil is more likely to stay in its current range or trend upwards.

With imports accounting for more than 50 percent of our supply, we are on the verge, once again, of seeing the huge costs that high prices hold for our economy. Worst of all, this is a problem that is at least partially of our own making. Over the years, our lands have been locked up and many of our most promising opportunities have been put out of reach.

The U.S. sits on huge unexplored oil reserves in the offshore, in my State of Alaska, in the Rocky Mountain West. We have shale formations that aren't even accessible for research and development right now. At times, our energy policy goes beyond frustrating and becomes simply irresponsible. The American people expect their Government to keep energy affordable, but right now, it is failing on that front.

We as citizens own the oil and the natural gas on Federal land. The Government is not a landlord, but a management outfit that we allow, through representatives in Congress, to contract for the development of these resources for our benefit. When the value of these resources is sustained at such high levels and we are overly dependent on foreign sources for our supply, there is not much tolerance for keeping them locked up. We essentially have money buried beneath our own soil, but instead choose to hemorrhage nearly \$1 billion a day out of our economy.

Now it is not that I expect our Nation to supply 100 percent of its own oil. We won't. It is not that I expect increased domestic production to singlehandedly bring down the price of oil back down to our preferred price range. It won't do that. But I do expect honesty in this discussion about what increased domestic production can do to protect against supply disruptions, increase our security, restore our trade balance, generate Government revenues, and, most of all, create jobs.

The events in North Africa should be a wake-up call to those of us who work on energy policy. Civil unrest is a fact of life in many of the nations that provide our imports. Iran now holds OPEC's presidency and is perfectly comfortable with \$100 oil. An actual supply disruption, as opposed to the mere specter of one, would likely spike oil prices to levels that will stifle our economic recovery and result in genuine hardship for American working families.

As this committee's joint background memo quoted from the Bipartisan Policy Center, they said, and I quote, "A one-dollar 1-day increase in a barrel of oil takes \$12 million out of the U.S. economy. If tensions in the Mideast cause oil prices to rise by \$5 for even just 3 months, over \$5 billion will leave the U.S. economy. Obviously, this is not a strategy for creating jobs." That is the end of the quote.

That is a tremendous amount of money. Really, we are talking about exponentially more when it comes to our deep dependence on foreign oil. So, today, I am renewing my call for a realistic and truly aggressive approach to the energy challenges we face. For the sake of our national security, for the sake of our economy, and for the sake of our world's environment, America should produce as much of the oil that it uses as possible.

It is this balance, in concert with the resulting revenues and the ease of manufacturing, that will allow us to truly take control of our energy future. I am anxious to work with Senators on both sides of this dais to achieve a more appropriate balance in our energy policy, a balance that promotes all forms of energy.

I thank the witnesses for the testimony that you have presented here this morning and look forward to the discussion that we will have.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much.

Why don't we start with you, Dr. Newell? If you could take 8 minutes or so and give us sort of the main points we need to understand? I would ask the same of each of the other witnesses, and we will include in the record your complete written statement in each case.

But Dr. Newell, go right ahead.

STATEMENT OF RICHARD NEWELL, ADMINISTRATOR, ENERGY INFORMATION ADMINISTRATION, DEPARTMENT OF ENERGY

Mr. NEWELL. Thank you, Mr. Chairman and members of the committee. I appreciate the opportunity to appear before you today.

The Energy Information Administration is the statistical and analytical agency within the U.S. Department of Energy. EIA does not promote or take positions on policy issues, and we have independence with respect to the information and the analysis that we provide. Therefore, our views should not be construed as representing those of the Department of Energy or other Federal agencies.

Focusing first on the short-term outlook for oil, EIA expects a continued tightening of world oil markets over the next 2 years. World oil consumption grows by an average of 1.5 million barrels per day in 2011 and in 2012 in our outlook, while supply growth from non-OPEC countries averages less than 0.1 million barrels per

day. Consequently, we expect the market to rely on increased OPEC members' production of crude oil and other liquids and some drawdown in inventories to meet world oil demand growth.

With tighter world oil markets, EIA expects the price of West Texas Intermediate crude oil, a key U.S. pricing benchmark, to average about \$93 per barrel in 2011, \$14 per barrel higher than last year's average. We expect the price to rise to an average of \$99 per barrel by the fourth quarter of 2012. However, oil price forecasts are subject to a great deal of uncertainty. For example, the market value of futures and options contracts, which we track closely, is telling us that there is about a 1-in-3 chance that the price of oil could be above \$110 per barrel at the end of this year.

EIA expects the retail price of regular gasoline to average about \$3.17 per gallon this year, about 40 cents per gallon higher than last year, and \$3.29 per gallon in 2012. Prices will be higher than this during the peak summer driving season and in certain regions of the country, particularly the west coast. There is also a significant chance that gasoline prices could diverge substantially from these values, particularly due to uncertainty in oil prices.

I will now turn to the longer-term energy projections from EIA's Annual Energy Outlook, which we update once each year. The reference case, which we released in December, represents an energy future through 2035—so, for the next 25 years—that assumes continuance of current market and technological trends, consumer behavior, and current laws and regulations. It does not include the effect of potential future policies that have not yet become law. The reference case represents a baseline that is a useful jumping-off point for assessing alternatives, and the full outlook, which we will release this spring, will include a large number of sensitivity cases that examine the impacts of different technological market assumptions and policy assumptions.

Renewables are the fastest-growing energy source in our outlook, albeit from a relatively small base. Total use of renewable fuels grows 3 percent per year on average, compared to overall energy consumption, which grows only less than 1 percent per year on an annual average basis. Growth in renewables results mainly from the implementation of renewable fuel standards, which is a Federal standard, and also State-level mandates for renewable electricity generation.

Turning to natural gas, the prospects for domestic natural gas production have dramatically improved over the last several years with the emergence of shale gas production. U.S. shale gas production has increased 15-fold over the last decade, and proved reserves of shale gas have tripled over the last few years. This has led EIA and other analysts to reassess the U.S. shale gas resource base, and in our new reference case just released, technically recoverable shale gas resources are more than double what we assumed in last year's outlook.

As a result, U.S. natural gas production increases 25 percent over the next 25 years, and our projections for natural gas imports and natural gas prices are, in turn, significantly lower than what we had previously assumed. Lower projected natural gas prices, in turn, underpin increased natural gas consumption, which rises 17

percent over the next 25 years, primarily for use in industry and electric power.

Coal is another key source for electricity generation, and coal consumption grows gradually throughout the reference case projection, as existing plants are used more intensively and the few new coal plants already under construction are completed and enter into service.

Nuclear generating capacity increases by about 10 gigawatts, from 101 gigawatts in 2009 to about 111 gigawatts by 2035. This includes about 6 gigawatts of new plant additions, with the balance coming from upgrades at existing plants.

Turning back to oil, the reference case crude oil prices continue to rise in our long-term outlook as a growing global economy underpins oil demand growth that is more rapid than supply growth from non-OPEC producers. By 2035, the reference case crude oil price is \$125 per barrel in real terms in our outlook.

Recognizing the possibility of unpredictable changes in energy markets and policies, the full Annual Energy Outlook to be issued this spring will include a wide range of oil price scenarios that diverge significantly from this reference case assumption.

Total U.S. consumption of oil and other liquid fuels grows from about 19 million barrels per day in 2009 to 22 million barrels per day in 2035 in the reference case. This modest growth in the reference case reflects increasing fuel prices and the implementation of finalized standards and statutory mandates that drive the fuel economy of light-duty vehicles to 35 miles per gallon by 2020. However, pending standards proposed for heavy-duty vehicles and potential changes in light-duty standards beyond 2017 are not reflected in the reference case.

Virtually all of the increase in liquids comes from biofuels use, driven by the Federal renewable fuel standard along with increases in natural gas liquids from natural gas production. We expect domestic oil production increases to come from onshore enhanced oil recovery projects and shale oil plays. Cumulative offshore oil production in this year's reference case is lower than in last year's outlook due to delays in near-term projects, changes in expected lease sales, and lower natural gas prices, which tend to be coupled with oil production.

As a result of this increased domestic production and modest consumption growth, we expect U.S. dependence on imported liquid fuels to continue to decline. After reaching a high of 60 percent in 2005, the imported petroleum share of total liquid fuel use fell to 52 percent in 2009 and continues to decline in our projections to 42 percent by 2035.

EIA's data analysis and projections are meant to assist policymakers in their deliberations and the private sector in making informed decisions. In addition to preparing baseline projections that I have reviewed this morning, EIA has also responded to requests from this committee and others for analysis of the energy and economic impacts of energy policy proposals. We look forward to providing you with whatever assistance you need in that regard.

Mr. Chairman, members of the committee, this concludes my testimony, and I look forward to any questions you might have.

Thank you.

[The prepared statement of Mr. Newell follows:]

PREPARED STATEMENT OF RICHARD NEWELL, ADMINISTRATOR, ENERGY INFORMATION
ADMINISTRATION, DEPARTMENT OF ENERGY

Mr. Chairman and Members of the Committee:

I appreciate the opportunity to appear before you today to discuss the energy and oil market outlook.

The U.S. Energy Information Administration (EIA) is the statistical and analytical agency within the U.S. Department of Energy. EIA collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding regarding energy and its interaction with the economy and the environment. EIA is the Nation's premier source of energy information and, by law, its data, analyses, and forecasts are independent of approval by any other officer or employee of the United States Government. The views expressed in our reports, therefore, should not be construed as representing those of the Department of Energy or other federal agencies.

The energy projections that I will discuss today are widely used by government agencies, the private sector, and academia as a starting point for their own energy analyses. EIA prepares both short-term energy outlooks, examining monthly trends over the next one to two years, and longterm outlooks, with annual projections over the next 20-to-25 years. While I will be focusing primarily on the long-term outlooks in my remarks today, I would like to first summarize some key findings from our January Short Term Energy Outlook, which includes monthly forecasts through the end of 2012.

THE SHORT-TERM ENERGY OUTLOOK

EIA's Short-Term Energy Outlook forecasts a continued tightening of world oil markets over the next 2 years. World oil consumption grows by an annual average of 1.5 million barrels per day through 2012 while the growth in supply from countries that are not members of the Organization of the Petroleum Exporting Countries (OPEC) averages less than 0.1 million barrels per day each year. Consequently, EIA expects the market will rely on both inventories and significant increases in the production of crude oil and non-crude liquids in OPEC member countries to meet world demand growth. While on-shore commercial oil inventories in the Organization for Economic Cooperation and Development (OECD) countries remained high last year, floating oil storage fell sharply in 2010, and projected OECD oil inventories decline over the forecast period. EIA expects that OPEC members' crude oil production will continue to rise over the next 2 years to accommodate increasing world oil consumption, especially with non-OPEC supplies expected to show limited growth. Projected OPEC crude oil production increases by 0.5 and 1.1 million barrels per day in 2011 and 2012, respectively.

Because of the projected tightening in world oil markets EIA expects the price of West Texas Intermediate (WTI) crude oil to average about \$93 per barrel in 2011, \$14 higher than the average price last year (Figure 1).^{*} For 2012, EIA expects WTI prices to continue to rise, with a forecast average price of \$99 per barrel in the fourth quarter 2012. Energy price forecasts are, however, uncertain. Based on futures and options prices as of January 31, 2011, the probability that the monthly average price of WTI crude oil will exceed \$110 per barrel in December 2011 is about 30 percent.

EIA expects regular-grade motor gasoline retail prices to average \$3.17 per gallon this year, 39 cents per gallon higher than last year and \$3.29 per gallon in 2012, with prices forecast to average about 5 cents per gallon higher in each year during the April through September peak driving season. There is regional variation in the forecast, with average expected prices on the West Coast about 25 cents per gallon above the national average during the April through September period. There is also significant uncertainty surrounding the forecast, with the current market prices of futures and options contracts for gasoline suggesting a 35 percent probability that the national average retail price for regular gasoline could exceed \$3.50 per gallon during summer 2011 and about a 10 percent probability that it could exceed \$4.00 per gallon.

Domestic natural gas production increased by an average 3.5 percent per year over the last 4 years, primarily because of the growth in production from unconventional shale gas resources. The growth in production has contributed to higher inventories, lower natural gas prices, and an increase in natural gas use in the elec-

^{*} Figures 1–13 have been retained in committee files.

tric power sector. The projected Henry Hub natural gas spot price averages \$4.02 per million Btu for 2011, \$0.37 per million Btu lower than the 2010 average (Figure 2). EIA expects the natural gas market to begin to tighten in 2012, with the Henry Hub spot price increasing to an average \$4.50 per million Btu.

EIA estimates fossil-fuel CO₂ emissions increased by 3.8 percent in 2010, after falling by 7.0 percent in 2009. Coal and natural gas-related CO₂ emissions rose as a result of increased usage of both fuels for electricity generation and higher consumption of natural gas in the industrial sector. Projected declines in coal and natural gas consumption in the electric power sector in 2011 more than offset increased consumption of petroleum in the transportation sector (i.e., motor gasoline, diesel fuel, and jet fuel). Consequently, forecast fossil-fuel CO₂ emissions fall by 0.6 percent in 2011. The forecast resumption of growth in electricity generation and improvement in economic growth in 2012 contribute to a 2.4-percent increase in fossil-fuel CO₂ emissions. Projected fossil-fuel CO₂ emissions in 2012 remain below the levels seen since 1999 and 4.4 percent below 2005 emissions.

LONG-TERM ENERGY OUTLOOKS

International Energy Outlook.—Before focusing on our U.S. Annual Energy Outlook, I want to briefly discuss some highlights of our International Energy Outlook 2010 (IEO2010), which was issued last May. The IEO2011 will be issued this spring. Although the Annual Energy Outlook focuses on our latest thoughts about domestic energy markets, it is useful to place this within a global context given the interconnectedness of U.S. energy markets and the broader global economy.

The United States accounted for one-fifth of the world's energy consumption in 2007, but this share is likely to decline over the next two decades. Global energy consumption will grow about 50 percent over the next 25 years, with most of the growth occurring outside of developed countries, in places like China, India, and the Middle East. Energy demand in non-OECD countries is expected to grow over 80 percent from 2007 levels, and by 2035 China will account for almost 25 percent of total world energy consumption. Renewables are the fastest-growing source of world energy supply, but under current market and technology trends fossil fuels are still expected to meet more than three-fourths of total energy needs in 2035, assuming current policies are unchanged.

Total global liquid fuels consumption projected for 2035 is 110.8 million barrels per day, which is 29 percent or 24.7 million barrels per day higher than the 2007 level of 86.1 million barrels per day. Conventional oil supplies from OPEC member countries contribute 11.0 million barrels per day to the total increase in world liquid fuels production from 2007 to 2035, and conventional supplies from non-OPEC countries add another 4.8 million barrels per day. World production of unconventional resources (including biofuels, oil sands, extra-heavy oil, coal-to-liquids, and gasso-liquids), which totaled 3.4 million barrels per day in 2007, increases fourfold to 13.5 million barrels per day in 2035.

Natural gas consumption increases 44 percent globally over the projection period. Tight gas, shale gas, and coalbed methane supplies increase substantially in the IEO2010 Reference case—especially from the United States, but also from Canada and China.

In the absence of additional national policies and/or binding international agreements that would limit or reduce greenhouse gas emissions, world coal consumption is projected to increase from 132 quadrillion Btu in 2007 to 206 quadrillion Btu in 2035, at an average annual rate of 1.6 percent. China alone accounts for 78 percent of the total net increase in world coal use from 2007 to 2035.

Annual Energy Outlook.—Turning to the Annual Energy Outlook 2011 (AEO2011), the Reference case discussed today was released in December 2010 and is intended to represent an energy future through 2035 based on given market, technological and demographic trends; current laws and regulations; and consumer behavior. EIA recognizes that projections of energy markets are highly uncertain and subject to geopolitical disruptions, technological breakthroughs, and other unforeseeable events. In addition, long-term trends in technology development, demographics, economic growth, and energy resources may evolve along a different path than represented in the projections. The complete AEO2011, which EIA will release this spring, will include a large number of alternative cases intended to examine these uncertainties.

EIA has made numerous updates in developing its AEO2011 Reference case. Several notable changes from the AEO2010 include (1) a significant update of the technically recoverable U.S. shale gas resources, more than doubling the volume of shale gas resources assumed in AEO2010; (2) an increase of the limit for blending ethanol into gasoline for approved vehicles from 10 percent to 15 percent; (3) incorporation

of California's Low Carbon Fuel Standard and other State environmental rules; and (4) updates in several key technology assumptions, including the cost of new power plants and the cost and sizes of electric and plug-in hybrid electric batteries.

ECONOMIC GROWTH

Real gross domestic product (GDP) grows by an average of 2.7 percent per year from 2009 to 2035 in the AEO2011 Reference case, the same as in the AEO2010 Reference case. The Nation's population, labor force, and productivity grow at annual rates of 0.9 percent, 0.7 percent, and 2.0 percent, respectively, from 2009 to 2035.

Beyond 2011, the economic assumptions underlying the AEO2011 Reference case reflect trend projections that do not include short-term fluctuations. The near-term scenario for economic growth is consistent with that in EIA's October 2010 Short-Term Energy Outlook.

It is important to note that one must exercise care in evaluating percentage growth relative to 2009 levels throughout the projection results since 2009 was the low point of the economic downturn and associated energy consumption.

ENERGY PRICES

World oil prices declined sharply in the second half of 2008 from their peak in mid-July of that year. Real prices trended upward throughout 2009, and through November 2010 they remained generally in a range between \$70 and \$85 per barrel before climbing above \$90 per barrel. Prices continue to rise gradually in the Reference case (Figure 3), as the world economy recovers and global demand grows more rapidly than liquids supplies from producers outside the Organization of the Petroleum Exporting Countries (OPEC). In 2035, the average real price of crude oil in the Reference case is \$125 per barrel in 2009 dollars.

The AEO2011 Reference case assumes that limitations on access to energy resources in resourcerich countries restrain the growth of non-OPEC conventional liquids production between 2009 and 2035, and that OPEC targets a relatively constant market share of total world liquids production (Figure 4). The degree to which non-OPEC and non-OECD countries restrict access to potentially productive resources contributes to world oil price uncertainty. Other factors causing uncertainty include OPEC investment decisions, which will affect future world oil prices and the economic viability of unconventional liquids. A wide range of price scenarios (from \$50 per barrel to \$200 dollars per barrel in 2035, in 2009 dollars) and discussion of the significant uncertainty surrounding future world oil prices will be included in the complete AEO2011 publication.

Prices of motor gasoline and diesel in the AEO2011 Reference case increase from \$2.35 and \$2.44 per gallon (all prices are in real 2009 dollars), respectively, in 2009 to \$3.69 and \$3.89 per gallon in 2035.

The price of natural gas at the wellhead is consistently lower in the AEO2011 Reference case than it was in AEO2010 (Figure 5), because of a revised representation of natural gas pricing and a significant increase in estimated technically recoverable shale gas resources. The annual average natural gas wellhead price remains under \$5 per thousand cubic feet through 2022, but rises thereafter to meet growth in natural gas demand and to offset declines in natural gas production from other sources. As the shale gas resource base is developed, production gradually shifts to resources that are somewhat less productive and more expensive to produce. Natural gas wellhead prices (in 2009 dollars) reach \$6.53 per thousand cubic feet in 2035, compared with \$8.19 per thousand cubic feet in AEO2010.

The average U.S. minemouth coal price declines somewhat after 2010, as the share of higher-cost coal from mines in Appalachia declines. The Appalachian share of total coal production, on an energy content basis, declines from 40 percent in 2009 to 33 percent in 2016 and 29 percent in 2035. The average, real delivered electricity price in the AEO2011 Reference case falls from 9.8 cents per kilowatthour in 2009 to 8.9 cents per kilowatthour in 2016, reflecting continued low natural gas prices. Electricity prices tend to reflect trends in natural gas prices, because natural gas represents a large share of total fuel costs, and in competitive areas natural gas-fired plants often are the marginal generators. In the AEO2011 Reference case, lower natural gas prices lead to lower electricity prices than in the AEO2010 Reference case. Electricity prices in 2035 (in 2009 dollars) are 9.2 cents per kilowatthour in the AEO2011 Reference case, compared with 10.3 cents per kilowatthour in the AEO2010 Reference case.

ENERGY CONSUMPTION

Total primary energy consumption, which was 101.7 quadrillion Btu in 2007, grows by 21 percent in the AEO2011 Reference case, from 94.8 quadrillion Btu in 2009 to 114.3 quadrillion Btu in 2035, to about the same level as in the AEO2010 projection in 2035 (Figure 6).

The energy intensity of the U.S. economy, measured as primary energy use (in Btu per dollar of GDP (in 2005 dollars)), declines by 40 percent from 2009 to 2035 in the AEO2011 Reference case as the result of a continued shift from energy-intensive manufacturing to services, rising energy prices, and the adoption of policies that promote energy efficiency. Since 1992, the energy intensity of the U.S. economy has declined on average by 2 percent per year, in large part because the economic output of the service sectors, which use relatively less energy per dollar of output, has grown at a pace almost 6 times that of the industrial sector (in constant dollar terms). As a result, the share of total shipments accounted for by the industrial sectors fell from 31 percent in 1992 to 24 percent in 2009. In the AEO2011 Reference case, the industrial share of total shipments continues to decline, but at a slower rate, to 21 percent in 2035.

Population is a key determinant of energy consumption, influencing demand for travel, housing, consumer goods, and services. The U.S. population increases by 27 percent from 2009 to 2035 in the AEO2011 Reference case, and energy consumption grows by 21 percent over the same period. Energy consumption per capita declines somewhat as a result, declining by an average of 0.2 percent per year from 2009 to 2035 in the AEO2011 Reference case.

The fossil fuel share of energy consumption falls from 84 percent of total U.S. energy demand in 2009 to 78 percent in 2035, reflecting rising fuel prices and the impacts of fuel economy standards and provisions in the American Recovery and Reinvestment Act of 2009 (ARRA), the Energy Improvement and Extension Act of 2008 (EIEA2008), the Energy Independence and Security Act of 2007 (EISA2007), and State legislation.

Total U.S. consumption of liquid fuels, including both fossil liquids and biofuels, grows from 18.8 million barrels per day in 2009 to 22.0 million barrels per day in 2035 in the AEO2011 Reference case. The transportation sector dominates the demand for liquid fuels and its share (as measured by energy content) grows only slightly, from 72 percent of total liquids consumption in 2009 to 74 percent in 2035. AEO2011 assumes the adoption of fuel economy standards for light-duty vehicles for model year 2011, as well as joint fuel economy and greenhouse gas emissions standards set forth by the EPA and NHTSA for model years 2012 through 2016. The fuel economy standards increase further through model year 2020 to meet the statutory requirements of EISA2007. The Reference case does not assume any further changes in fuel economy standards. Some ideas for further standards are discussed in the September 2010 EPA/NHTSA Notice of Upcoming Joint Rulemaking to Establish 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy (CAFE) Standards. Nor does it include the proposed fuel economy standards for heavy-duty vehicles provided in The Proposed Rule for Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, published by the EPA and the National Highway Traffic Safety Administration (NHTSA) in November 2010. Enactment of further binding standards would lower the projection for liquid fuels use.

Biofuels account for most of the growth in liquid fuels consumption, increasing by 1.8 million barrels per day from 2009 to 2035. The biofuel portion of 2035 liquid fuels consumption is 3.9 quadrillion Btu in AEO2011, about the same as in AEO2010. Although the situation is uncertain, EIA's present view of the projected rates of technology development and market penetration of cellulosic biofuel technologies suggests that available quantities of cellulosic biofuels will be insufficient to meet the renewable fuels standard (RFS) targets for cellulosic biofuels legislated in EISA2007 before 2022, triggering both waivers and a modification of applicable volumes, as provided in Section 211(o) of the Clean Air Act as amended in EISA2007.

In the AEO2011 Reference case, natural gas consumption rises from 22.7 trillion cubic feet in 2009 to 26.5 trillion cubic feet in 2035. The total in 2035 is about 1.6 trillion cubic feet higher than in the AEO2010 Reference case due to lower natural gas prices.

Total coal consumption, which was 22.7 quadrillion Btu in 2007, increases from 19.7 quadrillion Btu (1,000 million short tons) in 2009 to 25.2 quadrillion Btu (1,302 million short tons) in 2035 in the AEO2011 Reference case. Coal consumption, mostly for electric power generation, grows gradually throughout the projection period, as existing plants are used more intensively, and a few new plants already under

construction are completed and enter service. Coal consumption in the electric power sector in 2035 in the AEO2011 Reference case is about 1.3 quadrillion Btu (53 million short tons) lower than in the AEO2010 Reference case, however, as a result of higher levels of natural gas use for electric power generation due to relatively lower natural gas prices in the AEO2011 Reference case.

Total consumption of marketed renewable fuels grows by 2.9 percent per year in the AEO2011 Reference case. Growth in the consumption of renewable fuels results mainly from the implementation of the Federal RFS for transportation fuels and State renewable portfolio standard (RPS) programs for electricity generation. Marketed renewable fuels include wood, municipal waste, biomass, and hydroelectricity in the end-use sectors; hydroelectricity, geothermal, municipal waste, biomass, solar, and wind for generation in the electric power sector; and ethanol for gasoline blending and biomass-based diesel in the transportation sector. Excluding hydroelectricity, renewable energy consumption in the electric power sector grows from 113.6 billion kilowatthours in 2009 to 261.6 billion kilowatthours in 2035.

ENERGY PRODUCTION AND IMPORTS

Net imports of energy meet a major, but declining, share of total U.S. energy demand in the AEO2011 Reference case. Energy imports decline due to increased domestic natural gas production, increased use of biofuels (much of which are produced domestically), and demand reductions resulting from the adoption of new efficiency standards and rising energy prices. The net import share of total U.S. energy consumption in 2035 is 18 percent, compared with 24 percent in 2009. The share was 29 percent in 2007, but it dropped considerably during the recession.

OIL AND OTHER LIQUIDS

U.S. dependence on imported liquid fuels, measured as a share of total U.S. liquid fuel use, reached 60 percent in 2005 and 2006 before falling to 52 percent in 2009. The liquids import share continues to decline over the projection period, to 42 percent in 2035 (Figure 7).

In the AEO2011 Reference case, U.S. domestic crude oil production increases from 5.4 million barrels per day in 2009 to 5.7 million barrels per day in 2035. Production increases are expected from onshore enhanced oil recovery (EOR) projects, shale oil plays, and deepwater drilling in the Gulf of Mexico. Cumulatively, oil production in the lower 48 States in the AEO2011 Reference case is approximately the same as in the AEO2010 Reference case, but the pattern differs in that more onshore and less offshore oil is produced in AEO2011.

Onshore oil production is higher in AEO2011 as a result of an increase in EOR, as well as increased shale oil production, for which the resource estimate has been increased relative to AEO2010. In AEO2011, EOR accounts for 33 percent of cumulative onshore oil production. The bulk of the EOR production uses CO₂. For CO₂ EOR oil production, naturally produced CO₂ or man-made CO₂ captured from sources such as natural gas plants and power plants is injected into a reservoir to allow the oil to flow more easily to the well bore.

Offshore oil production in AEO2011 is lower than in AEO2010 throughout most of the projection period because of expected delays in near-term projects, in part as a result of drilling moratoria and associated regulatory changes, and in part due to the change in lease sales expected in the Pacific and Atlantic outer continental shelf (OCS), as well as increased uncertainty about future investment in offshore production.

As with natural gas, the application of horizontal drilling together with hydrofracturing techniques have allowed significant increases in the development of shale oil resources (oil resident in shale rock). With AEO2011 incorporating five key shale oil plays (as opposed to two in AEO2010), oil production rises significantly in areas of the country where shale oil is being produced, including the Rocky Mountains (primarily from the Bakken shale), the Gulf Coast (primarily from the Eagle Ford and Austin Chalk plays), the Southwest (primarily from the Avalon play), and California (primarily from the Lower Monterey and Santos plays).

NATURAL GAS

The emerging role of shale gas resources highlights the outlook for natural gas supply. Cumulative natural gas production in the lower 48 States over the projection period in the AEO2011 Reference case is 25 percent higher than in the AEO2010 Reference case as a result of greater supply availability from shale gas plays (Figure 8). The higher shale gas production and a higher rate of development results from the addition of shale gas resources in existing plays that can be produced at prices under \$7 per thousand cubic feet.

In the AEO2010 Reference case, technically recoverable unproved shale gas resources were estimated at 347 trillion cubic feet; in the AEO2011 Reference case they are estimated at 827 trillion cubic feet. The revised estimate results from the availability of additional information as more drilling activity takes place in both existing and new shale plays. U.S. shale gas production has increased 14-fold over the last decade, and reserves have tripled over the last few years (Figure 9).

As a result of updated shale gas resources in existing plays (key additions were in the Marcellus, Haynesville, and Eagle Ford plays) and an assumption of increased well productivity for the newer plays, shale gas production in 2035 in the AEO2011 Reference case is almost double that in the AEO2010 Reference case.

There is considerable uncertainty about the amounts of recoverable shale gas in both developed and undeveloped areas. Well characteristics and productivity vary widely not only across different plays but within individual plays. Initial production rates can vary by as much as a factor of 10 across a formation, and the productivity of adjacent gas wells can vary by as much as a factor of 2 or 3. Many shale formations, such as the Marcellus Shale, are so large that only a small portion of the entire formation has been intensively production-tested. Environmental considerations, particularly with respect to water, lend additional uncertainty. Although significant updates have been made to the estimates of undiscovered shale gas resources in newer areas, most of the resulting additions are not economically recoverable at AEO2011 prices and have little, if any, impact on the projection.

The Alaska natural gas pipeline, expected to be completed in 2023 in the AEO2010 Reference case, is not constructed in the AEO2011 Reference case. This change is a result of increased capital cost assumptions and lower natural gas well-head prices, which hurt the economics of the project over the projection period. Total U.S. net imports of natural gas in the AEO2011 Reference case are lower than in the AEO2010 Reference case (Figure 10), due in part to stronger North American production, less world liquefaction capacity than previously assumed, and increased use of LNG in markets outside North America.

COAL

Although coal remains the leading fuel for U.S. electricity generation, its share of total electricity generation is consistently lower in the AEO2011 Reference case than in the AEO2010 Reference case through about 2023 (but similar thereafter). As a consequence, total coal production is slightly lower in the AEO2011 Reference case than in the AEO2010 Reference case.

As U.S. coal use grows, domestic coal production increases at an average rate of 0.7 percent per year, from 21.6 quadrillion Btu (1,075 million short tons) in 2009 to 25.8 quadrillion Btu (1,305 million short tons) in 2035. Production from mines west of the Mississippi River trends upward over the entire projection period. Following a substantial decline in output between 2009 and 2015, coal production east of the Mississippi River remains relatively constant from 2015 through 2035. On a Btu basis, 60 percent of domestic coal production originates from States west of the Mississippi River in 2035, up from 50 percent in 2009.

Typically, trends in U.S. coal production are linked to its use for electricity generation, which currently accounts for 93 percent of total coal consumption. Coal consumption in the electric power sector in the AEO2011 Reference case (21.8 quadrillion Btu in 2035) is about 1.3 quadrillion Btu less than in the AEO2010 Reference case (23.1 quadrillion Btu in 2035). For the most part, the reduced outlook for coal consumption in the electricity sector is the result of lower natural gas prices that support increased generation from natural gas in the AEO2011 Reference case.

ELECTRICITY GENERATION

Total electricity consumption, including both purchases from electric power producers and onsite generation, grows 30 percent, from 3,745 billion kilowatthours in 2009 to 4,880 billion kilowatthours in 2035 in the AEO2011 Reference case, increasing at an average annual rate of 1.0 percent (Figure 11). The growth in electricity consumption continues to slow due to structural change in the economy away from manufacturing and more stringent appliance efficiency standards. The growth rate in the AEO2011 Reference case is about the same as in the AEO2010 Reference case.

Although the mix of investments in new power plants includes fewer coal-fired plants than other fuel technologies, a total of 21 gigawatts of coal-fired generating capacity is added from 2009 to 2035 in the AEO2011 Reference case. Coal remains the single largest energy source for electricity generation (Figure 12) because of continued reliance on existing coal-fired plants and the addition of some new plants in the absence of an explicit Federal policy to reduce greenhouse gas emissions. Con-

cerns about greenhouse gas emissions continue to slow the expansion of coal-fired capacity in the AEO2011 Reference case, even under current laws and policies. Lower projected fuel prices for new natural gas-fired plants also affect the relative economics of coal-fired capacity, as does the continued rise in construction costs for new coal-fired power plants. Total coal-fired generating capacity grows to 330 gigawatts in 2035 in the AEO2011 Reference case.

Compared with the AEO2010 Reference case, electricity generation from natural gas is higher in the AEO2011 Reference case, particularly over the next 10 years, during which natural gas prices remain low. New natural gas-fired plants are also much cheaper to build than new renewable or nuclear plants.

Nuclear generating capacity in the AEO2011 Reference case increases from 101 gigawatts in 2009 to 111 gigawatts in 2035, with 6.3 gigawatts of new capacity (5 new plants) and the balance coming from rerated capacity. Electricity generation from nuclear power plants grows 10 percent, from 799 billion kilowatthours in 2009 to 879 billion kilowatthours in 2035, accounting for about 17 percent of total generation in 2035 (compared with 20 percent in 2009). Higher construction costs for new nuclear plants in AEO2011, along with lower projected natural gas prices, make new nuclear capacity slightly less attractive than was projected in the AEO2010 Reference case.

Increased renewable energy consumption in the electric power sector, excluding hydropower, accounts for 23 percent of the growth in electricity generation from 2009 to 2035. Generation from renewable resources grows in response to key Federal tax credits, but it is lower in the AEO2011 Reference case than in the AEO2010 Reference case because of lower natural gas prices and somewhat higher costs for new wind power plants. The drop in renewable generation relative to AEO2010 is seen primarily in lower projections for wind and biomass generation. Growth in renewables is also supported by the many State requirements for renewable generation. The share of generation coming from renewable fuels (including conventional hydro) grows from 11 percent in 2009 to 14 percent in 2035. In the AEO2011 Reference case, federal tax credits for renewable generation are assumed to expire as enacted. Extension of these tax credits could have a large impact on renewable generation.

ENERGY-RELATED CARBON DIOXIDE EMISSIONS

After falling by 3 percent in 2008 and nearly 7 percent in 2009, largely driven by the economic downturn, projected U.S. energy-related CO₂ emissions in the AEO2011 Reference case do not return to 2005 levels (5,980 million metric tons) until 2027, and then rise by an additional 5 percent from 2027 to 2035, reaching 6,315 million metric tons in 2035 (Figure 13). Energy-related CO₂ emissions grow by 0.2 percent per year from 2005 to 2035. Emissions per capita fall by an average of 0.8 percent per year from 2005 to 2035, as growth in demand for electricity and transportation fuels is moderated by higher energy prices, efficiency standards, State RPS requirements, and Federal CAFE standards.

Energy-related CO₂ emissions reflect the share of fossil fuels in energy as well as the mix of fossil fuels consumed, because of their different carbon contents. Given the relatively high carbon content of coal and its current use to generate more than one-half of the U.S. electricity supply, prospects for CO₂ emissions depend in part on growth in electricity demand. After a decline from 2007 to 2009, electricity sales resume growth in 2012 in the AEO2011 Reference case, but the growth is tempered by a variety of regulatory and socioeconomic factors, including appliance and building efficiency standards, higher energy prices, shifts in housing growth, and the continued transition to a more service-oriented economy. With modest electricity demand growth and increased use of renewables for electricity generation influenced by RPS laws in many States, electricity-related CO₂ emissions grow by 18 percent from 2009 to 2035. Growth in CO₂ emissions from transportation activity also slows in comparison with the recent prerecession experience, as Federal CAFE standards increase the efficiency of the vehicle fleet, employment recovers slowly, and higher fuel prices moderate growth in travel.

Taken together, these factors tend to slow the growth in primary energy consumption and CO₂ emissions. As a result, energy-related CO₂ emissions grow by 16 percent from 2009 to 2035—lower than the 21-percent increase in total energy use. Over the same period, the economy becomes less carbon-intensive, as energy-related CO₂ emissions per dollar of GDP decline by 42 percent.

CONCLUSION

As I noted at the outset, while EIA does not take policy positions, its data, analyses, and projections are meant to assist policymakers in their energy deliberations.

In addition to the work on baseline projections that I have reviewed this morning, EIA has often responded to requests from this Committee and others for analyses of the energy and economic impacts of energy policy proposals. We look forward to providing whatever further analytical support that you may require on energy-related topics.

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

The CHAIRMAN. Thank you very much.
Ambassador Jones, why don't you go right ahead?

STATEMENT OF RICHARD H. JONES, DEPUTY EXECUTIVE DIRECTOR, INTERNATIONAL ENERGY AGENCY, PARIS, FRANCE

Mr. JONES. Thank you, Mr. Chairman.

Just for those who came in late, my name is Dick Jones. I have been the Deputy Executive Director of the International Energy Agency since September 2008. Prior to joining the IEA, I served for 32 years as a U.S. diplomat, mostly in Middle East oil producers. I was also Ambassador to Kazakhstan.

I am going to speak to you this morning about international energy trends today and over the next 25 years, focusing on 4 key topics: first, recent international oil price increases and their impact; second, the IEA role in emergency response to oil supply disruptions; third, recent developments in gas and coal markets; and finally, long-term trends in world energy.

The price of oil has risen more than 25 percent since last September. This week, ICE Brent has been priced above \$100 per barrel for the first time since 2008. Some blame this rapid increase on speculation. But recent data for the final quarter of 2010 suggest that it was good old supply and demand, with fear over political unrest in the Middle East thrown in during the past few weeks.

Will these high prices last? The IEA is skeptical. The situation today differs from 2008 in several key respects. OPEC has 3 times as much spare capacity now, has already shown a willingness to use it. OPEC production is up by 250,000 barrels, or maybe more, since November. OECD's stocks are also higher. Government stocks alone equal 60 days. Refining capacity has improved worldwide.

However, the Egyptian crisis remains the wild card. If international oil prices do stay at today's levels for the rest of 2011, it would bring us very close to an oil burden equal to 5 percent of world GDP, a level that is associated with 3 global recessions in the past 40 years. Today's tensions in the Middle East make it appropriate to review IEA's role in preparing for and coordinating international responses to oil supply disruptions.

To belong to the IEA, each member country must maintain strategic oil stocks of at least 90 days of net imports. These can be government stocks or commercial stocks, but the government must have the legal authority to order their release in an emergency. Most countries have a mix of public and private stocks, including the United States.

Stocks can either be in the form of crude oil or refined products. Again, many countries have both. However, the U.S. Strategic Petroleum Reserve only holds crude oil. Mr. Chairman, I recall that the IEA welcomed your bill in the previous Congress that would have changed that.

In a crisis, the IEA quickly consults with affected member countries, analyzes the likely impact, and then recommends a course of action to the group, such as the release of specific amounts of oil into the international markets. If an action is approved, we then work with the members to ensure that they all do their part. This includes regular reporting and consultation until there is an assessment that the disruption is over.

Outreach to important energy consumers outside of the IEA is also vital to managing a supply disruption, given the increasing weight that they play in world oil markets. In a crisis, we would also consult with important producers, including members of OPEC. Ten nonmembers took part in our latest emergency response training exercise, including China, India, and Russia.

Although serious oil crises have been fortunately rare over the past 35 years, in my short tenure at the IEA, I have already seen occasions when a public reminder that IEA countries hold emergency stocks helped calm jittery markets.

Besides oil, natural gas is also now garnering intense interest. American companies' success in producing gas from shale deposits is encouraging other countries to look for unconventional gas. Activity is growing in Australia, India, and China, but also in Poland and elsewhere.

Now it is going to probably take several years to know individual results. However, it is already clear that by causing a glut in supply, shale gas is shifting patterns of trade, having a major impact on gas prices around the world.

LNG slated to come to the United States is now going to Europe and Asia instead. In some markets, spot gas prices have been as low as a quarter to a third of oil on an energy basis. This is raising competition for pipeline gas, giving consumers in Europe a break. Gazprom is not very happy about that.

More gas also means more natural gas liquids, which are becoming an important factor in oil production at the margin. This is one reason why we see the oil market as being relatively well supplied for 2011. Abundant gas should help keep oil prices down. Eventually, more gas could even help with coal prices. But right now, coal prices are climbing due to strong demand in China and India for power generation.

For all these reasons, the IEA is very excited about gas, and we will release a special report on the golden age of gas here in Washington in June.

2011 is also a time of uncertainty for long-term energy analysts. What course will the incipient economic revival take? How will Government responses shape markets? In the most recent edition of our annual World Energy Outlook, WEO for short, we looked at what would likely happen to world energy if current policies continue for the next 25 years. The results were disquieting.

World energy demand would increase by about 50 percent. Fossil fuels would continue to dominate. Although oil use would only increase by a quarter, gas use would increase more than half and coal use by closer to 60 percent.

Growth in all forms of energy is expected to be driven by economic expansion in emerging economies, notably China and India. But also the Middle East becomes an important consumption cen-

ter. In fact, China, which only recently passed America as the world's largest energy consumer, is expected to double its consumption by 2035.

Another feature of this WEO scenario is growing market power for OPEC countries. Their oil production is set to increase from 40 percent of world output today to one half over the next 25 years. Moreover, more of the world's oil production will come from difficult and remote places, which means it will cost more in real terms.

In short, this scenario points to a less secure, more costly, and more environmentally harmful mix of energy than we have today. To avoid such an untenable energy future, WEO 2010 also contained proposals for an alternative path based on three main elements: first, a strong push to improve energy efficiency; second, rapid steps to decarbonize electricity production using renewables, nuclear power, and carbon capture and storage; and finally, accelerating the development of advanced vehicle technologies.

In our view, these steps would help improve lives all over the world by enhancing all countries' energy security, insulating economies from the price volatility inherent in fossil fuel energy markets, and reducing the pollution of our land, water, and air from the increased production, transport, and use of fossil fuels that would otherwise occur.

I want to stress, however, that our scenario does not foresee a rapid decline in use of fossil fuels, let alone an end to it. Rather, we advocate shifting our energy supply to a more varied and, thus, a more secure, affordable, and cleaner mix of sources.

Mr. Chairman, I would like to close with a brief personal comment. Having worked in the Middle East and the former Soviet Union and seeing the security, economic, and environmental impacts of the current world energy system firsthand, I am convinced that we can do better.

Thank you very much for your attention.

[The prepared statement of Mr. Jones follows:]

PREPARED STATEMENT OF RICHARD H. JONES, DEPUTY EXECUTIVE DIRECTOR,
INTERNATIONAL ENERGY AGENCY, PARIS, FRANCE

Mr. Chairman, Senator Murkowski, and Members of the Committee, I am grateful for the opportunity to come before you today to discuss the views of the International Energy Agency (IEA) on the outlook for, and major trends shaping, global energy and oil markets today and over the next 25 years. I hope that my testimony will help to inform the important work of this committee as it begins crafting policies in the new Congress.

A retired American diplomat with experience on Middle Eastern and energy issues, I have served as Deputy Executive Director of the International Energy Agency since September, 2008. The IEA is an intergovernmental organization that acts as an advisor to 28 member countries, including the United States, in their effort to ensure reliable, affordable and clean energy for their citizens. Founded during the 1973-74 oil crisis, the central role of the IEA was and remains to co-ordinate response measures in times of oil supply emergencies. As energy markets have evolved, however, so has the IEA. Its mandate today also incorporates work on market reform, energy-technology collaboration, climate-change policies and outreach to the rest of the world, especially major consumers and producers of energy including China, India, Russia and OPEC countries.

I will use my time this morning to focus on several key areas. The first is an assessment of recent oil price movements, and their potential impact on the global economy in the near term. I will follow this with a brief description of the IEA's role in responding to disruptions in the supply of oil. I then wish to touch on market

movements for other sources of energy, before speaking about the long term outlook for global energy.

RECENT OIL PRICE MOVEMENTS AND THEIR POTENTIAL IMPACT

Since last September, international oil prices have increased by more than 25%, and reached \$100 a barrel for the first time in more than two years on Monday.

It has been claimed by some that speculation on the price of oil was behind this rapid rise. However, data on supply and demand fundamentals for the fourth quarter of 2010 that has recently become available points more towards a market tightening due to stronger-than-expected demand in key consumers and a concurrent drawdown of commercial oil stocks in OECD countries. Reasons for this growth in demand include unseasonal weather patterns and better than expected global economic growth. More recently, it appears that prices were boosted by concern in the market that the ongoing demonstrations in Egypt may eventually lead to a disruption of oil shipments through that country or spread to important producer countries in the region.

Although some market observers have previously predicted that a combination of more and more demand, an impending scarcity of supply, and high revenue goals from producers will keep oil prices at around \$100 for a sustained period of time in 2011, we do not see the current situation as a vindication of that point of view.

Were prices to remain at this level for a sustained period of time, however, oil expenditures would soon rise as a proportion of GDP, creating an 'oil burden' that could put a drag on the world economy. (This burden is calculated by analysing nominal—as opposed to inflation adjusted—oil expenditures, as a percentage of nominal GDP.) In fact, in the past, whenever the oil burden has been calculated at 5% or more, it is usually associated with an impending economic slowdown (see figure).*

The rise in prices over the last few months brings the oil burden too close to this 5% mark for comfort. Fortunately, there are elements of stability in the current market, which simply weren't there in 2008. For example, OPEC has much more spare capacity than it did in 2008 and OECD member countries have ample stocks of oil. There are already signs that some OPEC producers may be feeding extra supply to the market. Refining capacity is also in better shape than it was in 2008. While it's too soon to be confident, such factors could help cap prices in 2011, by ensuring there is a sufficient supply of oil.

IEA'S ROLE IN RESPONDING TO DISRUPTIONS IN THE SUPPLY OF OIL

Here I would like to note that IEA member countries are well equipped to respond to a disruption in their oil supply. As a condition of membership in the Agency, each of the IEA's 28 member countries is required to hold strategic oil stocks equivalent to 90 days of its net imports. Since being established in the aftermath of the first oil crisis, a fundamental part of our work has focused and continues to focus on planning for and helping co-ordinate a collective IEA response to major disruptions in oil supply.

Our work in this area now also includes many countries outside the IEA membership, such as China and India and other countries in Asia, which are also boosting their oil stocks or taking other measures to enhance their energy security, and have sought our advice. Last November we held our fifth major Emergency Response Exercise in Paris with the active participation of 10 non-Member countries.

Emergency stocks, now growing in more and more countries, are a vital aspect of global energy security, as countries are able to add measured amounts of oil to the market in the event of large-scale disruptions to supply over an extended period. You will recall that this was last done back in 2005, when oil stocks were released after Hurricane Katrina and Rita ripped through the Gulf of Mexico, damaging offshore oil rigs, pipelines and oil refineries.

MARKET MOVEMENTS FOR OTHER SOURCES OF ENERGY

Moving on from oil, the IEA also follows the international markets for other major fossil sources of energy, where recent developments are also worth noting.

Recent success with US production of significant amounts of 'unconventional' sources of gas, mainly from shale deposits, has sparked a flurry of interest throughout the world. Australia is leading the charge, but China, India and Indonesia are also seriously investigating their own 'unconventional' gas sources. In Europe, work is proceeding in Poland and elsewhere.

*Graphic has been retained in committee files.

Based on current rates of consumption, it is estimated that recoverable conventional gas resources will last around 130 years, but this could be doubled with 'unconventional' gas. These resources may also exist in countries which lack significant reserves of conventional gas; it is little wonder that the current scramble is now firmly underway.

Soaring production of 'unconventional' gas in the US has already led to a sharp drop in its need to import gas. This slump in US import demand is having a significant impact on global gas markets which have also been hit by the international economic crisis. Meanwhile, ample supplies, mostly from Qatar, of Liquefied Natural Gas have been arriving in the market. This has led to a 'gas glut'—and a diversion of LNG cargoes to Europe. Spot prices of gas in Europe consequently have fallen, putting downward pressure on the price of gas supplied under long-term contracts from Russia.

This is an example of why the IEA strongly urges countries to make their gas markets work as efficiently as possible, efficient markets help promote competition among suppliers. This is an important step for maintaining affordable prices.

In contrast to natural gas, coal prices have been rising, largely because of growing demand from China and India. Even though both countries are massive coal producers themselves, and are almost self sufficient in coal, their economic growth is so rapid that they must increasingly look elsewhere for additional supplies.

While their imports are small relative to their total coal use, the amount of coal they are looking to import is at such a level that it impacts heavily on the global coal trade, affecting traded coal prices sharply. Of course, in many parts of the world, because of transport costs and quality differences coal is not subject to global price pressures, and as such coal remains a competitively priced fuel, able to supply power at affordable prices.

THE LONG-TERM OUTLOOK FOR GLOBAL ENERGY

Last November, the IEA released the 2010 edition of its World Energy Outlook (WEO-2010). There are no 'facts' about the future, but the report does provide helpful insights into the evolution of our global energy system. Perhaps most importantly it highlights that the energy outlook over the next quarter century hinges critically on government policy action, and how that action affects technology, the price of energy services and end-user behavior.

Today we will share some of the key results of our Current Policies Scenario, which is comparable to the EIA's Reference Scenario, in which we assume that government policies continue unchanged. World primary energy demand rises by 47% between today and 2035 in the Current Policies Scenario. Fossil fuels (oil, coal and natural gas) remain the dominant source of energy during that time, even as cleaner energy sources make gradual inroads. Oil demand increases by 24%, natural gas by 56% and, owing to relative abundance and low cost, coal demand increases by 59%. Electricity demand nearly doubles by 2035.

Emerging economies are responsible for over 90% of the projected growth in primary energy demand. As a result, the OECD share of global energy demand, which declined from 61% when the IEA was set-up in 1973 to around 42% today, falls to just 35% in 2035. The surge in non-OECD energy consumption is led by brisk growth in China, where demand doubles by 2035, dwarfing increases in any other country or region. Over the past year we have witnessed an historic re-ordering of energy heavyweights, with China surpassing the United States to become the world's top energy consumer. Remarkably, energy use in China was only half that of the United States just ten years ago. This underscores that developments on the global energy landscape remain highly sensitive to the various factors that drive energy demand in China, including prospects for economic growth, changes in economic structure and developments in energy and environmental policies.

World oil demand experiences strong growth over the medium-and long-term. Based on preliminary data, we estimate that global oil demand in 2010 reached almost 88 million barrels per day (mb/d), the highest level on record. We project a rise to 107 mb/d in 2035, with all of the increase coming from non-OECD countries, led by China, India and the Middle East. In OECD countries, oil demand is expected to fall with improvements in vehicle efficiency; US demand, for example, is projected to drop by 1.7 mb/d, or 10%, between today and 2035.

Oil supplies will come from an increasingly concentrated group of producers that hold the majority of remaining low-cost resources. OPEC's share of global oil supply is set to expand from 40% today to 50% in 2035, as oil production in most non-OPEC countries has peaked (e.g. the United States, the North Sea), or will soon peak. These trends occur against the backdrop of an industry in flux. Opportunities for international oil companies, which have historically dominated oil sector develop-

ment, are diminishing with the growing role of national oil companies and fewer reserves in accessible basins outside OPEC countries. Oil market challenges are further exacerbated by the prospect of accelerating decline rates for individual oilfields, particularly in non-OPEC countries; this includes Mexico—a major exporter of crude oil to the United States. To meet new demand growth and offset decline in currently producing fields, gross capacity more than six times the current capacity of Saudi Arabia will have to be installed by 2035. The world's total endowment of oil is large enough to support the projected growth in output, but it will require substantial levels of investment and development of more technically challenging and unconventional resources.

The outlook for natural gas demand is particularly uncertain. The gas glut I mentioned earlier could have far-reaching consequences for the entire energy sector. It is expected to keep pressure on gas exporters to move away from oil-price indexation, particularly in Europe. Lower prices could lead to stronger demand for gas, backing out renewables and/or coal in power generation. To inform the policy debate on these issues, the IEA is currently preparing a new report on the “Golden Age of Gas” which we plan to release here in Washington in early June. The projections in our Current Policies Scenario have profound implications for three elements vital to sound energy policy:

- First, energy security. Without policy changes, fossil-fuels continue to dominate the energy mix at the expense of the enhanced security that a more diverse set of energy sources would provide. Furthermore, international shipments of energy commodities will have to expand substantially to accommodate the growing geographic mismatch between demand and production. While energy supplies will become more flexible in some respects (e.g. growing trade of liquefied natural gas vs pipelines), expanding international trade unavoidably increases dependence on physically vulnerable transit routes and infrastructure, which poses greater risks in tight markets.
- Second, economic development. In the absence of policy changes, few meaningful alternatives to oil are expected to be available before 2035. As prices steadily rise, importing countries without prospects for new development will continue to face higher import bills that pose a mounting and potentially unsustainable economic burden.
- Third, environmental protection. Without new initiatives to slow the growth in fossil-fuel use, energy-related air pollution will increase. Emissions of carbon-dioxide alone will jump from 29 Gt in 2008 to 43 Gt in 2035, an increase of 45%. According to analysis undertaken for the Intergovernmental Panel on Climate Change, this emissions trajectory could lead to a global average temperature increase exceeding six degrees Celsius.

These all add up to the conclusion that the global energy system, in which all countries are interdependent, faces a future that is increasingly untenable. To continue business-as-usual risks heightened insecurity, increasing economic volatility, and irreparable harm to the environment. We truly need a transformation in the world's energy system to a more secure, sustainable model, but of course this is much easier to say than it is to accomplish.

The first step is to understand the extent of the necessary transformation. To help with this, the World Energy Outlook also presents a “450 Scenario” which is essentially a roadmap of what needs to be done to move to a truly sustainable energy future. To be frank, the scale of the challenge is immense. Carbon intensity would have to fall at 2.8% per year through 2020, and then by 5.3% per year until 2035. Keep in mind the 1973 oil price shock resulted in a 2.5% improvement in carbon intensity—in one year only—illustrating the daunting challenge of achieving those levels of improvement each and every year.

The 450 Scenario confirms that promoting energy efficiency remains the quickest, most cost-effective approach to achieving our security, economic and environmental goals. This is the lowest hanging fruit we must pick first. A fundamental change will also be needed in the power and transport sectors. The global share of renewable-based electricity generation, for example, needs to rise to more than 45% by 2035—two-and-a-half times higher than today. The share of nuclear power in total generation needs to increase by about 50% over current levels. By 2035, electricity generation from coal plants fitted with carbon capture and storage (CCS) equipment exceeds that from coal plants without the technology. In transport, biofuels and advanced vehicles will need to play a much larger role. By 2035, about 70% of global passenger-car sales will need to be advanced vehicles (hybrids, plug-in hybrids and electric cars). The benefits of this scenario are not only environmental; it would also significantly enhance our energy security by spurring greater diversity in the global

energy mix, and reducing fuel import dependence. These results will in turn have important economic benefits for the vast majority of countries.

Mr. Chairman, Senator Murkowski, and Members of the Committee this completes my testimony. I would be happy to answer any questions you may have.

The CHAIRMAN. Thank you very much for your testimony.
Mr. Diwan, go right ahead.

**STATEMENT OF ROGER DIWAN, PARTNER AND HEAD OF
FINANCIAL ADVISORY, PFC ENERGY**

Mr. DIWAN. Mr. Chairman, Senator Murkowski, and members of the committee, I am grateful to have the opportunity to come before you today to discuss PFC Energy, my company's view on the oil markets.

I hope that my comments today will help you to understand better the present situation in oil markets, and I am going to focus my remarks really on 4 points, in particular on the short to medium term, the next 2 years in terms of oil markets.

First, when we look at the fundamentals, so the supply demand situation, and we look at the oil market right now, the way I would describe them is they are well supplied. Demand is rising almost exclusively in non-OECD markets in the next 2 years, with the depths of the demand not very strong because we are really counting on two areas to grow very strongly, which is China and the Middle East and a little bit of the rest of Asia.

OECD countries are not showing strong demand growth. So, and this unbalanced demand, if you want, makes global demand not particularly strong. I agree with Dr. Newell, it is around 1.5 million barrels per day in the next 2 years.

On the supply side, global liquid production—and I would like to include crude, gas liquids, and biofuels, all the liquids—have shown very strong growth in 2010. It is a record year. The question, is it a 1-year wonder, or is it telling us something more? I don't think that we will have such a strong growth in 2011 and 2012, but I think 2011 actually will show good numbers, probably close to 1 million barrels per day for a demand of 1.5 million barrels per day.

The question is why do we believe that? The beginning of an answer seems to be showing that, actually, high oil prices are having an impact on supply for the first time in very long time. We have had high oil prices now for almost 8 years, and we start to see supply reacting both in crude, but also, obviously, in natural gas and creating a lot of liquids and biofuels to compete with crude oil. I will speak a little bit more about that.

Finally, stocks, worldwide stocks actually are at respectable levels, above historical norms, and in certain areas clearly oversupplied. So if you look at oil markets today, you don't see visible tension in oil markets like we saw 2 or 3 years ago.

The second point is that not only oil markets are well supplied, but we have a very large cushion in terms of spare capacity, probably above 5 million barrels per day. In historical terms, this is a very high number and in percentage of demand, it is also a high number. We don't believe that that number will shrink dramatically in the next 2 years. Maybe a million barrels per day, maybe a little less, maybe a little more. So what we are describing as a well-supplied oil market is not changing dramatically in the next

2 years unless you have an exogenous factor, a crisis removing supply.

Moreover, when we look at these numbers, we are not factoring Iraq and the potential increase in production and capacity in Iraq in these numbers. So outside an exogenous crisis, markets are well supplied.

Obviously, we have a crisis right now, but we don't have any supply disruption. In a way, what we see in Egypt shows the good and the bad in the oil market. It reacts very quickly even if there is no supply. But at the end of the day, the reaction, I think, is short-lived and not very dramatic. Basically, prices moved by \$5, and already we are starting to lose that as no disruption has occurred. At PFC, we do not believe that actually there is a strong chance of any disruptions.

Finally, and probably the most difficult part is to understand prices and price formation. I have been looking at oil prices now for almost 20 years, and they remain a mystery for me. Because when you look at the present situation in the oil market in terms of supply, demand, stocks, spare capacity, et cetera, oil price is at \$90. But you know, 10 years ago, with exactly the same numbers, oil prices would have been at \$15. Five years ago, they would have been at \$40. Two years ago, they would have been at \$100.

So the exact numbers do not predict an oil price level. They more predict a price path, if you want. So how do we account for having oil prices at let us say between \$70 and \$90 this year with this type of fundamentals? I think we really need to look at broader issues to understand that, and the one I would like really to talk to you today, the one which I think is very important is really the margin—the price of marginal supplies.

Basically, at what price or what price you need to bring new barrels of oil into production. So how high the price has to go to push for new investment in more marginal areas. Obviously, you are going to invest first in your most profitable potential fields, and the more marginal ones come as prices rise.

The marginal fields in the world right now, being in Canada or Brazil or some fields in the United States, requires probably north of \$70 to be break-even prices. So oil prices only have risen to bring more supply to market. OK? Is it \$70, is it \$80 and \$90, I don't know, and I am not sure there is a clear number there. But that marginal price is important to bring new supply, and we are in the zone which is attracting new supply.

The second important determinant of oil prices for me is really the internal needs of producing countries. It is what the Gulf countries in particular and the OPEC producer require internally to balance their budget at the end of the day. It is pretty much their only resources.

When you look at the countries in general and you look at their balance of payment, they all have budgeted around \$70, \$80 oil. So, in a way, they believe that is the way the market is going to be there, and they are constraining supply to stay close to these prices.

In my view, they are fairly reactive to the marginal price, rather than setting it. So, in a way, the OPEC tolerance for high prices

increase as prices increase rather than as they push prices higher—as the market pushes prices higher, their tolerance increases.

The third element, which is very important and I came here a couple of years ago to discuss, really is the financialization of oil. Oil has become an investable asset, like equity, fixed income, gold, dollar, or other commodities. The flow of money actually is quite important in determining how in the short term price move and determining that price path, and that is quite important.

We have seen some important changes in the last few months, I think, and we can talk more about that in the Q&A. I feel there is less ability to increase prices very quickly through just money flows.

I will stop here my comments and probably will come back to more during the Q&A, and thank you for giving me the opportunity to come and talk about that in front of you.

[The prepared statement of Mr. Diwan follows:]

PREPARED STATEMENT OF ROGER DIWAN, PARTNER AND HEAD, FINANCIAL ADVISORY,
PFC ENERGY

OIL MARKET OUTLOOK FOR 2011-2012

More than ever, the world is seeing a two-speed economy. Nearly all of the world economy is expanding again, but the divergence between recovery in the developed world and strong growth in the emerging markets is becoming more pronounced. In both Europe and the United States the medium-term outlook remains unexciting—the financial crisis that caused the recession is over, but its consequences will persist for years to come. In contrast, emerging markets are contending with the problems of excessively rapid growth—especially as it stokes inflation exacerbated by loose monetary policy. Despite concerns over inflation and the potential for monetary tightening in key emerging markets like China, the period through 2012 will likely see continued oil demand support that will far surpass any potential OECD demand increase.

Although slowing from the 2.3 mmb/d global oil demand growth realized in 2010, PFC Energy forecasts demand to increase around 1.4 mmb/d in both 2011 and 2012. Global consumption over this period will be driven entirely by the emerging market economies, as economic stabilization also leads to marginal net changes in advanced economies' oil demand. Gains in non-OPEC supplies (including OPEC NGLs) and further ramping up of new Iraqi production will be sufficient to meet the bulk of this incremental demand. Although there is some projected shortfall in new supplies' ability to completely satisfy demand requirements, the first half of the year will still be characterized by a relative over-supply in physical markets. But the tightening of the market by the second half of the year will prove supportive of higher prices, reflected in our upward revision in our price forecast for WTI to a 2011 average of \$90.75/b and \$96.25/b in 2012, with average quarterly prices reaching the \$100/b mark toward the end of this two-year period.

The growing turmoil in the Middle East is providing a bullish factor for oil markets right now. The instability in Egypt has pushed prices up, but PFC Energy views the potential impact on oil supplies as virtually nil, and that includes the Suez Canal. Protests have spread across much of North Africa, as well as Yemen, but the major oil producing countries of the Gulf states have seen little in the way of unrest. Since Tunisia's Bin Ali was pushed from office, several governments have taken measures to promptly address the food price issue and have re-instated food subsidies. Bolstered by strong balance sheets routinely leveraged to lower political unrest, and still enjoying the support of many of its citizens, the Gulf countries will likely have no difficulty keeping regimes, oil supply, and still ample spare capacity intact. And even if in more oil producing North African states the protesters achieved a Tunisian style victory, a lack of cohesiveness regarding the next step would be unlikely to dislodge the state apparatus, particularly that associated with oil production and marketing, or in the case of Egypt, disruption in Suez shipments.

US ECONOMY SLOWLY GETTING BACK ON ITS FEET

The United States has shrugged off fears of a double-dip recession—GDP growth has more or less returned to its pre-recession trend rate of 2.5%—but without recov-

ering to its full potential output. Failure to do that means the economy is producing less than it could, and employing less labor as a result. Reengaging these idled resources is the most important policy challenge for the US government, but there may be little more that can be done while household and bank finances remain encumbered with debt. This suggests that high levels of unemployment are likely to persist for years.

Even so, there now appears to be a reliable base of private sector support for sustainable growth at these modest employment and capacity utilization levels. For nearly two years government transfers staved off a decline in real disposable income, but over the past two quarters underlying real income growth has risen back to a 2-2.5% range. At the same time, the personal savings rate has stabilized in a range of 5-6% of disposable income, substantially higher than the preceding decade but still below the longer-term historical average of 8-10%. Taken together, these data point to a sustainable 2-2.5% growth rate in personal consumption—and given the 70% GDP share of personal consumption that underpins PFC Energy’s expectation that overall growth will be in the same range.

Other sources of growth are unlikely to add or subtract much to this underlying rate. Business investment has made a strong recovery from the depths of the recession, but appears to have stabilized at a modest 2-3% growth rate. Although capacity utilization rates had risen sharply from record lows, they have lately shown signs of stalling out at a level that still leaves significant slack in the economy and little incentive for large-scale new investment. Spending by the public sector will almost certainly decline this year, especially at the state and local level. As for trade, despite an encouraging rise in exports late last year it is still more likely that the deficit will widen than expand, making a net negative contribution to growth.

Given these considerations, PFC Energy has revised upward its North American oil demand growth forecast for 2011 and 2012. After having grown by over 550 mb/d last year (essentially replacing 25% of the cumulative demand lost in 2008-09), we are confident that a sustained US recovery would add at least another 175 mb/d to North American demand levels this year (24.1 mmb/d versus 23.9 mmb/d in 2010). It is our perspective that structural changes to underlying US fuel consumption patterns have not been dramatically affected by higher oil prices in the lead-up to the Great Recession, and that unrealized demand for motor fuels remains. Income, more than price, seems to be the driving factor not only for US motorists, but for US consumers writ large.

Indeed, middle distillate demand (i.e., the primary fuels used in commerce and air travel) was far more heavily impacted than gasoline, falling at an average rate of 7% per year in 2008-09 versus gasoline’s -1.6%. It is notable that gasoline’s postrecession recovery has also been less pronounced than that of middle distillates, underscoring the relative paucity of non-oil personal transportation alternatives in the United States as well as motorists’ preference for gasoline. The contraction in 2008-09 highlighted the sensitivity of discretionary automotive use, not automotive use in general (or even a sweeping change in preference in favor of smaller cars). But whereas gasoline demand increased by 1% last year, diesel and jet fuel consumption surged by 3.5%—reflecting improved industrial activity and retail sales. Similar to the situation facing the general economy, middle distillates still have a long way to go in order to make up for the volumes of demand lost during the recession, and it is unlikely in our view that they will be able to do so by the end of 2012.

In addition to the demand recovery gap from middle distillates, other parts of the barrel are also unlikely to return to pre-recession levels over the next two years. The product categories most likely to be affected are at the heavier end of the spectrum, fuel oil and “other oils” (mainly asphalt). While the structural decline in the former has been common knowledge for years, weakness in asphalt is becoming more pronounced due to public sector budgetary constraints for transportation investment. This will likely become more pronounced this year as many US states struggle to fill widening budget deficits.

For North America as a whole, stabilized economic conditions mean an improvement in cross-border trade and economic growth. Other localized factors do impact our forecast (for instance, the much more fundamentally sound nature of the Canadian economy compared to Mexico’s), but for the region as a whole we see demand rising by 225 mb/d in 2011 and 200 mb/d in 2012 (up 70 mb/d and 40 mb/d respectively since our December Global Oil Markets Report).

EUROPE: PERIPHERY WEIGHS DOWN THE CORE

In contrast to the United States, Europe faces a serious threat to growth from the spreading Eurozone debt crisis—which has forced governments to accelerate fiscal

adjustment even at the risk of undermining a still-fragile recovery. Portugal seems almost certain to join Greece and Ireland under an IMF emergency program with Spain likely to follow. Promises of austerity and a more buoyant European economy have done little to ease the pressure on the weakest governments. Until markets believe that their finances are on a sustainable path, they will be unable to raise funding without public assistance.

The result is a clouded European outlook. Most European economies returned to growth in 2010, but the peripheral countries have either remained in recession or look poised to fall back into it. Adjustment policies in these countries aim to slash public spending and promote price deflation, but in weak economic conditions this is a guarantee of recession—and a further deterioration in public finances. The combination of state spending cuts and falling wages is already sparking political opposition, and this is certain to grow stronger. Problems in the periphery will hamper growth elsewhere, both through reduced trade and renewed financial sector difficulties. This suggests a weak growth forecast even if the Eurozone manages to muddle through 2011, but a slide back into recession if the debt crisis spreads beyond Spain.

A Europe splintered along structural economic fault lines is reflected in oil demand. Whereas the industrial powerhouse of Europe—Germany—continues to track along (pulling Poland and other smaller Central European countries along with it), other EU member states have simply stagnated and the so-called “peripheral countries” continue to contract.

Accordingly, PFC Energy expects the contraction in total OECD European oil product demand to bottom out in the second quarter of 2011 before rising to post yearly gains in 2012 (posting growth of -20 mb/d and +105 mb/d in 2011 and 2012, respectively). In contrast to North America, risks to this forecast are more to the downside, especially if the Euro zone financial crisis spreads to Italy and Spain.

ASIAN DEMAND LEADS THE WAY

A long restocking cycle and easy, if not stimulative, monetary and fiscal policies underpinned a generally strong Asian economic performance and increased oil demand throughout 2010. But while China has embarked upon an ambitious attempt to re-orient its economy toward consumption-led growth, the majority of Southeast Asian economies have simply increased their economic export sector dependence. In 2011 this business-as-usual approach will result in lower growth for these countries. Aside from OECD goods import demand showing little upside for additional expansion and commodities inflation on the rise again, China’s own economic transition (which encompasses reduction of both exports and imports) bodes ill for other Asian intermediate and capital goods.

While Japan and South Korea will need to continue emphasizing high-end niche markets, Southeast Asia must find avenues for effectively competing or partnering with China as well as stimulating domestic demand. But these are long-term processes and even if undertaken in 2011 all signs point to moderating economic growth. Even China will see somewhat slower growth, despite its large domestic consumption potential and strong industrial support from import substitution. After the country’s GDP expanded by just over 10% last year, slowing growth in industrial production, lending, government spending and net exports is likely to reduce growth this year to about 9%. One of the key factors for these decelerations is increasingly difficult year-on-year comparisons: a weaker first half 2011 for example will find it hard to show gains against a strong 2010 base.

Aside from such accounting, inflationary pressures, particularly in rising food and housing prices, may also limit growth. Much of the year-to-year inflation, which has now reached 5%, has been a function of declining prices in the prior year period. But even as this base effect recedes, inflation is expected to exceed Beijing’s new 2011 inflation target of 4% and likely stabilize at slightly under 5%.

The soon-to-be ratified Five-Year Plan (covering the period 2011-2015) goes beyond the emphasis on domestic consumption to an emphasis on several strategic industries, with energy efficiency and alternative energy sources an overriding concern—including an aim to limit the increase of oil consumption. While much of the groundwork for implementing these measures will be done during 2011-2012, no significant impacts are expected to appear before later in the five year period. Growth in China’s oil consumption is expected to slow in 2011 to 490 mb/d (compared to 600 mb/d in 2010) and register 540 mb/d in 2012, but these trends reflect primarily the general economic conditions (and accounting effects), rather than any significant impact from initial stages of re-structuring along the guidelines laid out in the Five-Year Plan.

As with the global economy more generally, the most pronounced economic and oil demand weakness in Asia lies within the advanced economies. But the largest

factors affecting the outlook for demand in the OECD Pacific region are more strongly influenced by developments in China than domestic economic conditions. These countries managed to keep demand flat in 2010 due to strong Chinese demand for Japanese and Korean goods in wake of the global restocking cycle as well as due to capricious weather. With this support fading in 2011 and a large cut in naphtha demand looming (as their petrochemical exports to China are crowded out by Chinese domestic production), OECD Pacific oil demand will continue to structurally decline through 2012, registering total losses of 190 mb/d during the forecast period.

Large domestic consumption capacity has also been a driving force for Indian oil demand, which is expected to expand by a moderate 95 mb/d and 113 mb/d in 2011-2012. Substitution of liquid fuels in power generation and fertilizer feedstocks by natural gas, as well as likely monetary tightening will prevent greater demand growth. Total Asian oil demand growth to slow to slightly around 500 mb/d and 550 mb/d in 2011 and 2012, markedly down from the 820 mb/d growth seen in 2010.

CHALLENGES FOR MIDDLE EAST ENERGY

The Middle East is largely on a strong growth path that should weather even stronger than expected economic headwinds. The most salient risks to growth primarily reflect the problems of success. The primary challenges include managing increased power demand, containing inflationary pressures and ensuring sufficient job growth for locals, and are largely manageable in the short term. Power demand issues were marginally better this past summer, and a strong focus on investment in power generation should continue to improve this issue. Chronic unemployment in the region is an issue that has been present for years, but a prior baby boom will cause these issues to increase in the coming years as the number of new entrants to the labor force peak.

Within the context of those challenges, 2011 demand growth in the Middle East is forecast to be 320 mb/d. This is slightly lower than last year's 382 mb/d pace, but is not reflective of a slowdown in the region. Instead it reflects primarily a deceleration of the increase in demand by Saudi Arabia after changing its policies in 2008 to emphasize fuel oil (and subsequently, crude) burning for power generation. While the effects of the policy change are largely complete, continued increased demand to meet electricity demands will be the primary driver in Saudi Arabia's 190 mb/d growth this year. It is anticipated that this summer crude demand for power generation will average 886 mb/d and could reach peaks as high as 1,150 mb/d in the high heat of the summer.

This power demand will continue to grow strongly as construction projects are still in development throughout the region, with much of the construction activity centered in Saudi Arabia and Abu Dhabi—the new home for many of the construction cranes that were previously in Dubai. While most of Dubai's construction was underwritten by foreign debt, the construction boom now underway is largely financed or underwritten by foreign investors, and will allow continued growth in gasoil and other construction related fuels. The large financial reserves coupled with scant foreign debt for the major oil producers provides the region significant buffers from any further shocks to the global system. Consumer demand is also increasing as the recovery in car sales for the region is expected to continue, and with it gasoline demand, expected to rise 45 mb/d this year. Transportation demand is also expanding from the increased use of aircraft, a trend occurring globally during this recovery, but is even more of a factor for the Middle East as its flight capacity expands and it becomes an increasingly important hub for travel to Asia. This will help boost kerjet demand by an estimated 30 mb/d in 2011.

IRAN'S SUBSIDY REFORM

Iran is a lone growth exception for the region, and it is expected to show another year of net demand decline in 2011. These declines are attributed to the strictures of an increasingly difficult multi-lateral sanctions program as well as the four-fold price increases introduced last December as part of a comprehensive subsidy restructuring. Demand in 2011 is forecast to decline 31 mb/d, with gasoline declining an estimated 30 mb/d as Iranians seek out alternative transportation. The alternatives include buses, which have already experienced increases in demand in the days after the price increases were announced. This factor that provides one of the few bright spots for Iranian demand, with diesel fuel expected to rise 15 mb/d on this increased public transportation use.

Given the relatively staid reception these price increases have had on the population (albeit under heavy police and Basij presence to shut down protests before they started) it could be that they will be absorbed with relatively little change in

the actual appetite for the fuels. However, the lack of any consumer outrage can also be attributed to the initial offsetting subsidy payment of \$120 (representing three months of accrued subsidy payments—in the future these payments will continue to be \$40 per month).

The real effect of this change could be felt in the broader economy as the increased fuel prices translate into decreased consumer discretionary spending, as well as increased other costs across the board. President Mahmoud Ahmadinejad's plan seeks to avoid this particular problem with limited allowable price increases for businesses most affected by the fuel price increases, which in turn could shrink profit margins in other sectors and lead to lower business confidence. In the future, if the increased prices are believed to cause long-term economic problems, Tehran's response is likely to raise direct subsidy payments rather than roll back pump prices. This is in keeping with Ahmadinejad's plan to use the subsidy reform as a platform to strengthen his position within his political base, the rural poor, and a section of the population that saw limited benefits from the old subsidy program due to their low fuel consumption levels.

LATIN AMERICA: AN ECONOMIC RENAISSANCE?

Latin American oil demand in 2010 recovered with a near 300 mb/d increase, a pace expected to slow to 230 mb/d in 2011. The deceleration is affected by base effects and changes in the macroeconomic climate, but 2010 was also punctuated by a number of significant weather events that increased demand. While the impact of such weather events is expected to be diminished this year, current drought conditions in Argentina are likely to negatively affect agriculture output, and by extension diesel demand growth.

Brazil continues to be the demand linchpin for the region, accounting for 163 mb/d of oil demand growth in 2010, a number that will slow to 120 mb/d in 2011. This oil demand growth was supported not just by an expanding economy and increased spending, but also a poor sugarcane harvest that pushed motorists to fuel up with gasoline C (a gasoline mix with a low, fixed level of ethanol) over hydrous ethanol (a straight ethanol product suitable for use in most Brazilians flex-fuel vehicles). A near record planting season in the fourth quarter should increase supplies of the fuel by the second half of the year, reducing the demand growth from gasoline, barring poor weather.

As the region has been exposed and profited from the recovery of commodity prices, demand support across the barrel has remained strong. Car sales have recovered from the low levels during the recession, fueled in part by tax incentives. But, at least in Brazil's case, the elimination of such incentives caused a downturn in sales for only a short period of time before recovering again. It is expected that even without such incentives Brazil car sales (now fourth largest in the world) will likely reach a new record in 2011.

SUPPLY GROWTH LARGELY SATISFIES DEMAND

Although oil prices are moving to higher trading ranges on demand and general economic optimism, current liquids supply trends suggest that expected demand growth in 2011 and 2012 can easily be met from gains in non-OPEC production and OPEC gas liquids with only marginal demands on the still substantial OPEC spare capacity. Gains in non-OPEC liquids in 2010 are set to come in around 1.0 mmb/d although these increases will likely slow in 2011 and 2012. OPEC gas liquids will continue growing in both forecast years as domestic and export oriented gas projects reach full operation. And OPEC effective spare crude capacity is currently estimated at 5.7 mmb/d, providing the ability to cover any disappointments in non-OPEC performance—or unforeseen supply disruptions—throughout the forecast period.

PFC Energy forecasts 2011 non-OPEC supplies (including not only crude, but also gas liquids and biofuels) will increase by around 540 mb/d—a bit more bullish than prior estimates. The crude portion of this gain is 210 mb/d, somewhat lower than 2010's 640 mb/d increase. Most of this stems from the expectation that US crude output will decline rather than increase in 2011 as output drops in the Gulf of Mexico owing both to a lack of additional planned new projects as well as the drilling moratorium. Further adding to the slowdown will be smaller gains in Russia and China as new project start-ups are fewer in number exerting less of an upward pull.

The year 2012 is forecasted to show only a 60 mb/d gain in total non-OPEC production. The key reason for the drop is a 230 mb/d decrease in crude supplies as ongoing depletion in most countries will offset gains in those few that are adding to production. Key oil plays showing increases over the next two years include Canada's oil sands, Brazil's deepwater, Colombia's Llanos basin, Ghana (the Jubilee field that started mid December) and Oman (Oxy's Mukhaizna project). But these

gains combined cannot offset declines in the United States, North Sea and Mexico as well as numerous smaller producers in Latin America, MENA and the Far East.

The other two elements of non-OPEC supply, gas liquids and biofuels, continue to show gains in both forecast years. Gas liquids (condensates and NGLs) should move up by around 175 mb/d in 2011 and 125 mb/d in 2012. They are increasing simply from the many countries pursuing gas projects to meet domestic energy demand. But the largest increase in 2010 and expected for 2011 is the United States. Both from increases in natural gas output as shale gas development continues (seemingly regardless of the weak price environment) and the incentive to look for areas with liquids rich gas (given strong oil prices that push up liquids values well above natural gas values) the country should see about a 100 mb/d increase in 2010 followed by 40-50 mb/d in 2011 and stabilizing in later years.

Biofuels will add another 150-160 mb/d per year in the forecast years. As in the past, the two main sources of biofuels output growth will be the United States and Brazil. After seeing an increase in ethanol production estimated at 160 mb/d in 2010 (a good 70% of 2010's global increase in biofuels output), gains in the United States will moderate to the 40 mb/d range unless a blend rate above the current 10% is approved. Current restrictions approving a higher ethanol content for late model cars only makes it infeasible to implement at the retail level. Brazil should see steady annual growth of 40-50 mb/d as well. Other areas of the world are expected to add 40-50 mb/d per year, mainly biodiesel in Europe and Southeast Asia. However, with recent concerns over renewed food price inflation and intermittent support from governments, these assumed gains are far from locked in and could ultimately come in under our current estimate.

OPEC non-quota-constrained gas liquids are making an impact on global balances, although somewhat haltingly due to construction delays and lengthy commissioning times. After adding an estimated 415 mb/d to supplies in 2010, OPEC gas liquids should see additional growth averaging about 420 mb/d in both 2011 and 2012. Qatar is the key contributor, stemming from expansion of its LNG industry that is nearing completion. As the trains reach full operational output in 2011 gas liquids will continue to grow. Another important contributor will be start-up in 2011 of Shell's Pearl GTL project whose first phase will throw off another 70 mb/d of gas liquids. Saudi Arabia and the UAE are the other main contributors as both countries pursue oil and gas projects that will lead to increases in condensates and NGLs.

At one time, Iran was expected to see equal if not larger gains in gas liquids output, but delays to the country's South Pars project schedule stemming from ongoing sanctions suggest minor gains over the next couple of years. This compares to the steady increases seen over the past decade, when the first of the now completed first eight phases of South Pars went into service. Kuwait is also being held back from further development of its sour and high pressure gas reserves until agreements are reached with foreign companies that can assist with the technical challenges of such development.

OPEC: BOTH THE CALL AND ACTUAL OUTPUT TO REMAIN STEADY

This expansion of global liquids outside of quota constrained OPEC crude reached 1.4 mmb/d in 2010 covering almost 60% of the robust demand growth (+2.3 mmb/d). Similarly, non-OPEC liquids plus OPEC NGLs should cover about 1.0 mmb/d of 2011's 1.4 mmb/d demand increment, or about 70% of expected demand growth. The call on OPEC should begin to rise more significantly in 2012, when projected gains in total non-OPEC liquids should net only 0.5 mmb/d, or roughly 35% of incremental demand. Based on this supply and demand path, 2012 could see the first major increase in the call on OPEC crude totaling almost 1.0 mmb/d. after a relatively minor 0.5 mmb/d increase in 2011.

This does not however suggest a material tightening of supply conditions is in the offing. Capacity expansions in Saudi Arabia as well as maintained production restraint throughout the Gulf Arab and North African member states leave effective spare capacity at 5.7 mmb/d. Both absolute and relative spare capacity are at levels not seen since the 1990s—an era of very weak prices. But a combination of operational flexibility and strategic considerations—both at the commercial strategic level of the operating national oil companies as well as in the political perspectives of the member states—means that such high levels of spare capacity will not play the same bearish role it has in the past.

However it is not only quota members who are increasing capacity, but Iraq as well. PFC Energy's forecast sees Iraqi production rising 380 mb/d by year end 2011 and a similar amount by year end 2012. And progress is being made. ENI announced in early December that it was now in the cost recovery and fee payment

phase with the Zubair field, triggered when production hit 10% above the initial output rate of 183 mb/d. And BP announced this week that the 10% threshold on the 1.077 mmb/d Rumaila field has been met as well. Assuming that existing export infrastructure is improved, these projected additional incremental volumes coming in 2011 should be able to reach market. In addition to increases in Iraq southern volumes, we are still holding to our assumption that Kurdistan exports will re-start and average about 70 mb/d for the year. For 2011, Iraq's annual average output should move up by about 400 mb/d, with a similar increment expected in 2012.

STOCKS AND BALANCES SHOW TIGHTENING

Between non-OPEC and OPEC the world is well supplied with liquids. Even if 2011 or 2012 demand proves more robust than thought, supplies should readily be available to cover increased crude needs at OPEC's discretion depending on price and actual global stock changes. The unexpectedly sharp increase in 2010 oil demand—and third quarter draws from total commercial stocks—has lessened PFC Energy's concerns over impending stock builds in the first half of 2011. This is reflected in a substantial upward revision to our 1Q11 price outlook (\$92/b for WTI). However, the early part of this year nevertheless still features not insignificant builds of nearly 1.0 mmb/d. A near-term continuation of oversupply conditions (albeit greatly reduced from our previous estimates) suggest prices may still weaken on a fundamentals basis over the second quarter (\$86/b). From then onward our global supply/demand balance points to continual price increases through the end of the forecast period, eventually averaging \$100/b in 4Q12.

Despite the projected rise in prices, PFC Energy does not see OPEC substantially raising production in the next several months. Even with concerns of long term demand destruction and worries of another price spike potentially derailing the global economic recovery, the results of rising prices so far have not shown strong oil prices to be particularly pernicious. Furthermore, the global overhang of oil products has only just begun to recede, making risks to the downside from adverse change in the fundamentals less of a threat. Saudi Oil Minister Ali Naimi's characterization of \$90/b as the new fair oil price was less a statement on the Kingdom's targeting of such a price level, but rather that current prices were achieved primarily as a result of a healthy return of demand. The pull of consumption on prices therefore also guards against threats that rising oil prices could de-rail the economy. OPEC is likely comforted in this assessment by the judgment that rising nonenergy commodity prices produced little noticeable drag on economic performance in 2010. While general inflationary troubles could translate into economic and political problems over time, for the moment OPEC's concerns may turn to favoring further nominal price increases, even if only an attempt to preserve the purchasing power of the dollardenominated barrel. And perhaps most fundamentally of all, the cartel may be willing to resume its prior stance of taking pro-active steps to guard against downside price risks and address upside demand surprises reactively—a position that helped generate the historic boom in oil prices from 2004.

[All tables and graphs have been retained in committee files.]

The CHAIRMAN. Thank you very much for your testimony.
Mr. Burkhard, go right ahead.

STATEMENT OF JAMES BURKHARD, MANAGING DIRECTOR, IHS CAMBRIDGE ENERGY RESEARCH ASSOCIATES, CAM- BRIDGE, MA

Mr. BURKHARD. Thank you, Mr. Chairman, other members of the committee. We really appreciate the opportunity to share some thoughts with you about energy and oil in particular.

Oil prices and gasoline prices are, as we all know, very visible. Millions of people see them every day when they fill up at the pump. It was just 2 ½ years ago when we saw oil above \$140, and then it was just 2 years ago when oil prices sunk close to \$30 a barrel. These swings have had a great impact on Americans and the economy.

Oil prices are on the rise again, and it is raising questions yet again about the impact on the economy and why are we seeing

these kind of prices? The turmoil in Egypt raises the question about geopolitical stability of world oil supplies.

Now what is happening in Egypt is part of a broader story, something we would refer to as a global redesign. A global redesign is what we describe as a period of change, deep change of the formal and informal mechanisms that shape and manage international relations.

There is no blueprint for this global redesign, but it is clear that the pace, the distribution of economic growth is affecting the global balance of economic, political, and military power all at a time when the world faces extraordinary questions about macroeconomic management, security, and energy. Oil demand, supply, and price are key variables that will shape this redesign, and energy overall will play a significant element.

The political upheaval in Egypt has provoked anxiety in oil markets. The oil market is always fearful when there is a threat to big oil exporters in North Africa and even bigger ones clustered in the Persian Gulf. Egypt is not a major exporter. It is, in fact, a slight importer. But about 2 to 4 percent of global supplies does transit Egypt, and what happens in Egypt obviously has an impact beyond its borders in the Middle East.

So oil prices are considerably higher. But looking back at what has happened over the last decade, it goes beyond just concerns about stability in the Middle East. There are many reasons that explain what has happened. But perhaps the most important, the core of what has happened is the stunning increase in income and GDP in China, India, and other emerging markets.

We all know this, but looking at some of these statistics really just shows how stunning this is. In the last decade, GDP per capita in China is up 235 percent, 235 percent. In India, it is up 176 percent. That is from 2000 to 2010. Stunning.

Rarely, if ever, have we seen living standards for so many rise so quickly. This is due, to some extent, to the breath-taking spread and success of market-based decisionmaking in nearly every corner of the world.

Now, some of the growth of the past decade was based on misplaced exuberance, and we still are grappling with that painful aftermath. But the broad trends of rising global prosperity are intact. Just look at how successful the economies of India and China have been since 2008.

Over the last decade, demand in emerging markets has increased about 12.2 million barrels per day. That is roughly equivalent to the entire production capacity of Saudi Arabia. That is what has happened in emerging markets. Again, at the core of this, the higher incomes, aspirations for higher living standards. There are other factors as well that have played into this. Roger went into a few, and I will amplify some of those.

One on the supply side, the law of long lead times. It can take anywhere from a couple of years to more than a decade to bring on a new oil field. You don't develop and bring on a new field overnight just because the price went up.

Also, high industry costs. This was perhaps arguably the second most important trend in the oil markets over the past decade. From 2005 to 2008, according to the IHS CERA Upstream Capital

Cost Index, which is sort of a consumer price index for the oil industry, in that short time period, 2005 to 2008, the cost of developing a field doubled on average around the world. So, in other words, a company had to pay double in 2008 in order to develop the same barrel of oil that compared to 2005 prices.

Other factors as well, oil has become the new gold. It is a financial asset in which investors take positions based on their expectations of the value of the dollar, inflation, and global oil demand and supply. The role of financial players has gotten a lot of interest over the years, especially in 2008, and they can accentuate a given price trend. But the primary reasons of price trends are rooted in the fundamentals of supply, demand, industry costs, and geopolitics.

So what does this all mean for today and the future? One, it is a reminder that the oil market is a reflection of the world. That means prices go up and down in response to what is happening around the world. But perhaps more importantly, what does this mean for the future?

In 2010, there is about 1 billion members of what you could call the global middle class. That is people who live in countries with per capita GDP of \$10,000 or more. About a billion. By 2030, so in 20 years, that will have grown to about 2.5 to 3.5 billion people in the global middle class. So a billion today, over the next 20 years, 2.5 to 3.5 billion people in countries with per capita income of \$10,000 or more. That means more oil, more oil demand.

There is a strong case for prices, for oil prices to be above levels we have seen for most of the past 20 to 30 years. This will reflect continued prosperity around the world. It will foster innovation and efficiency. Does it mean prices are inevitably going to continue to rise and rise? No. There are some factors that will offset that.

One is the view that has been voiced already is peak demand in the OECD—Europe, North America, South Korea, Japan, Australia. We do believe that oil demand in the OECD peaked in 2005, petroleum-based oil demand, and it will not exceed that level again. Fuel economy, biofuel mandates, demographics, the global health boom has turned into a global aging boom. That tends to lower oil consumption.

All of this figures into the changing balance of power, this global redesign. There is no blueprint for how this is going to unfold, and there will be, of course, times of turmoil, which we are seeing today unfold in Egypt. To conclude, the energy prices, and especially oil, will continue to reflect the shifting fortunes of the global economy and geopolitics.

Thank you.

[The prepared statement of Mr. Burkhard follows:]

PREPARED STATEMENT OF JAMES BURKHARD, MANAGING DIRECTOR, IHS CAMBRIDGE ENERGY RESEARCH ASSOCIATES

It is an honor to speak on the energy and oil market outlook before the US Senate Committee on Energy and Natural Resources of the 112th Congress. It is very timely for the Committee to assess the current situation. I hope to provide a framework that will help to understand what we are seeing in world oil markets—and why. It was just two and a half years ago that oil surged to over \$140 a barrel and just two years ago that it sank close to \$30 a barrel. These swings had great impact on the economy and on the American people. Prices that were in the high \$80s and low \$90s have surged once again on the upheaval in Egypt. Once more there are

questions about the impact of oil on the overall economy—and why we are seeing these kind of prices. The turmoil in Egypt has raised anew the concerns about the geopolitical stability of world oil supplies. Egypt is an important transit point for delivering Middle East oil to the global market via the Suez Canal and the Sumed pipeline. In recent years, combined oil flows from the canal and the pipeline have ranged from 1.7 million barrels per day (mbd) to 3.3 mbd. The high end of this range is equivalent to about 3.8 percent of world oil production.

The pace and distribution of economic growth is affecting the global balance of economic, political, and military power—all at a time when the world faces extraordinary questions about macroeconomic management, security, energy, and the environment. The world is in the midst of what we refer to as a “Global Redesign”—a period of change for the formal and informal mechanisms that shape and manage international relations.¹ Oil demand, supply, and price are key variables that will shape this redesign—as will energy overall.

Oil prices are in a range considerably higher than in the past. There are many reasons, but the most important reason of all is the change in the world economy and rise of major new, dynamic growth centers. Oil is our largest source of energy—about 37 percent of total US energy—and is essential to personal mobility, commerce, and trade. Its price reflects the global economy—the ups and downs, the surprises, and shifting expectations about geopolitics, technology, and economic growth.

US ROLE IN THE OIL AND GAS INDUSTRY

The United States plays a major role in the oil and gas industry. We are the largest consumer of oil and gas in the world, but what is perhaps less recognized is the key role on the supply side. The United States is the world’s largest producer of natural gas, the third largest for oil, and number two for coal. The United States is also a big producer of renewable energy. It is the largest biofuel producer in the world and has a growing portfolio of wind and solar power generation capacity. Oil and gas production plays an important role in the economy of producing areas of the United States. For example, in four states along the US Gulf of Mexico—Louisiana, Texas, Alabama, and Mississippi—the offshore oil and gas industry accounts for nearly 400,000 jobs that generate \$70 billion in economic value. This does not include the jobs created in Pennsylvania, Connecticut, Ohio, and a number of other states that provide equipment and services to the offshore industry.

Domestic energy production is dynamic—its size is not simply a legacy of past investments. A recent “game-changing” development is the revolution in unconventional gas production in the United States. The unlocking of “shale gas” was led by the innovation and risk-taking of American companies. Innovation in gas extraction has also resulted in higher oil production. In 2009 the US recorded the largest increase of oil and gas production in the world—a growth trend that continued in 2010.

Another striking development of the past few years is the increasing integration of the US and Canadian energy markets. Canada leads development of the oil sands—an important component of global oil supply growth. The oil sands have made Canada the largest supplier—by far—of foreign oil to the United States, and this source has become part of the fabric of our continental energy security. Since 2000 Canadian oil sands output has more than doubled—from 600,000 barrels per day (bd) to 1.4 million barrels per day (mbd) in 2010. Total Canadian oil exports (crude oil and refined products) to the United States are 2.5 mbd, about double the number two supplier, Mexico. Canadian oil accounts for 21 percent of our total oil imports.

WHAT SHAPES OIL PRICES?

The US energy industry is a substantial investor, supplier, and employer, but it is also part of a larger and increasingly global market. Oil is the most global of energy markets and exemplifies a dynamic, flexible, and competitive trading system. The price of oil—and particularly of gasoline—is highly visible. We see it every time we fill up at the pump. But the factors that shape the price are often not as readily visible as the brightly lit signs listing the price of a gallon of gasoline.

Electric power bottlenecks in China have, at times, contributed to greater use of oil in that country for backup power generation, boosting oil demand. This was one of the reasons that pushed oil demand up 9.7 percent in China last year. This created a volume gain of 810,000 bd, which was one of the largest recorded gains in a single country in the past several decades. Rising global steel costs for the petroleum industry—up 122 percent since 2003—are an example of what may appear to

¹ See the Multiclient Study IHS CERA Energy Scenarios.

be an obscure industrial trend, but one that has contributed to much higher costs to develop new oil fields. China's demand dynamics and the trend in steel costs are just two of many examples of how developments around the world influence what Americans pay at the pump, but which don't come to the attention of most consumers.

Crude oil is fungible. This means, for example, that a barrel of oil produced in Africa can be refined anywhere in the world into gasoline, diesel, and jet fuel. Price signals help determine where to ship more or less oil. Nearly all the world's oil sales are directly linked or influenced by one of two "benchmark" crude oils: West Texas Intermediate (WTI) in Cushing, Oklahoma, or Brent in the United Kingdom. The price of a specific crude oil will vary from these benchmarks by as little as a few pennies or by as much as a number of dollars, depending on its quality and the cost of transporting it to a refinery. The futures markets for both WTI and Brent are well developed with large daily trading volumes.

Flexibility and capability to allocate supply in response to price signals are the foundation of the oil market—and explain how it has withstood economic shocks, demand spikes, and supply outages. But with flexibility and responsiveness comes exposure to a broad array of forces of change around the world. These forces can both lower and increase the price of oil. A very recent example is the unrest in Egypt. While not a major producer itself, Egypt is a key oil transit point and an influential country in the world's most important oil producing region.

Dawn of a New Age

The past decade was an exceptional time in the oil market. For a generation—up until 2003—oil prices generally hovered from \$10 to \$30 per barrel. A \$5 to \$10 shift in the price of oil was an extraordinary development. But this all changed over the next several years as oil prices rose from an annual average of \$26 in 2002 to an all-time annual average high of nearly \$100 in 2008. The period of 2003 to 2008 was the "dawn of a new age" in oil and energy markets. The driver was the unprecedented increase in income and gross domestic product in Asia, Latin America, the Middle East, and other emerging markets. Rarely, if ever, have living standards risen for so many across the globe in such a short time. Per capita economic output in China soared 235 percent between 2000 and 2010. India's per capita output rose 176 percent.

Poverty reduction, rising income, and aspirations for higher living standards mean more oil demand—and this is what we have seen over the past decade. Oil demand increased 42 percent in emerging markets from 2000 to 2010—a volume increase of 12.2 million barrels per day.² This is roughly equivalent to the entire production capacity of Saudi Arabia. But in contrast to emerging markets, demand in developed markets—Europe, North America, and OECD members in Asia—was lower in 2010 than in 2000.³ The contrasting demand patterns reduced the developed markets' share of world oil demand from 63 percent in 2000 to 53 percent by 2010. But the volume growth in emerging markets more than offset the decline in developed markets. World oil demand in 2010 stood at 87.3 mbd—an all-time high. After two years of falling world oil demand, 2010 registered the second largest gain in more than three decades. Emerging markets were, again, the main driver of this growth.

Oil Supply: Law of Long Lead Times

Demand trends are a critical piece of the oil price story, but there are others as well. On the supply side the oil industry is ruled by the law of long lead times. The time it takes to explore for and discover oil, develop a field, and deliver the oil to market can range from several years to more than a decade, depending on the size and location of the resource base, the reservoir characteristics, and the business environment. Rising oil prices encourage more investment in oil production, but long lead times mean there is often a mismatch between a surge in demand and when investment in a new oil development leads to additional supply. New fields cannot be developed overnight.

Higher Industry Costs

As oil prices rose and investment in new supplies increased for much of the past decade, so did demand for the people and equipment needed to find, develop, and produce oil. But the previous legacy of more than two decades of low oil prices and industry consolidation meant a "missing generation" in the energy chain—a genera-

²Emerging markets are generally defined as countries outside of North America, Europe and OECD members in Asia (Japan, South Korea, Australia and New Zealand.)

³The OECD is the Organization for Economic Cooperation and Development.

tion of engineers, scientists, and others who skipped entering the petroleum industry. As a result, shortages of equipment and personnel dramatically raised the cost of developing an oil field. The IHS CERA Upstream Capital Costs Index—sort of a “consumer price index” for the global oil industry—illustrates the cost pressure. From 2005 to 2008 our cost index doubled. In other words companies had to budget twice as much in 2008 as they did in 2005 to develop a barrel of oil. Adding to the cost pressure were increasingly heavy fiscal terms on oil investments in the form of higher taxes and greater state participation globally in oil projects. Costs did decline slightly in the aftermath of the Great Recession and subsequent fall in oil prices; but since the middle of 2010 costs have been on the rise again and currently stand close to the cost peak of 2008 (see Figure 1).*

The Role of Global Financial Dynamics

Oil has long figured into the workings of financial markets. Since the 1978 launch of the first heating oil contract on the New York Mercantile Exchange, it has been possible for investors to buy and sell oil contracts without being an active participant in the physical oil business. Such “noncommercial” market participants are essential to any futures market. In exchange for providing price certainty to a producer or consumer of oil, a trader has the opportunity to turn a profit—or a loss—from future price changes.

Financial market investors—including those in oil futures—represent a broad spectrum of investors with different time frames and motivations. They allocate capital based on current and expected global demand for oil and other commodities. Also, since oil is priced in US dollars, changes in the value of the dollar can and do influence the price of oil. Oil has become “the new gold”—a financial asset in which investors stake positions based on their expectations of the value of the dollar, inflation, and global demand and supply of oil. The role of noncommercial investors can accentuate a given price trend. However, the primary reasons for price movements in recent years are rooted in the fundamentals of demand and supply, geopolitical risks, and industry costs.

THE PRICE OF OIL: A REFLECTION OF THE WORLD

The story of the price of oil over the past decade is a reflection of the changes in the world. At the core is the breathtaking spread and success of market-based decision making in nearly every corner of the world that has allowed hundreds of millions of people to benefit from expansion of trade and investment. In the future historians may look back at the early part of the 21st century as an extraordinary period of wealth creation in today’s emerging markets. To be sure, the Great Recession revealed that some of the growth of the past decade was based on misplaced exuberance—and we are still grappling with the painful aftermath. But the broad trend of rising prosperity around the world is still intact—a trend borne out by the impressive performance of the Chinese and Indian economies since 2008.

The Outlook: A Boom in the Global Middle Class

Financial market dynamics, industry cost trends, innovation, and the pace of investment will continue to influence the price of oil. But ultimately the level of oil demand is likely to exert the greatest impact.

In the past two decades the population of countries with per capita income of less than \$10,000 was booming. Now many of those countries are well on the way to entering the ranks of the global middle class. In IHS CERA’s latest energy outlook, we project over that the next 20 years an unprecedented number of people will enter the global middle class—countries with per capita incomes above \$10,000. The global middle class will rise from less than a billion people in 2010 to between 2.7 and 3.5 billion in 2030. More people will be able to purchase a car, travel by plane, and consume electricity generated by coal, gas, nuclear, and renewable sources. When it comes to rising economic power, China and India garner much of the attention—and rightfully so given their massive populations. But this story will also unfold elsewhere in the world in parts of Africa, Latin America, and the Middle East.

Does this mean that rapidly rising oil prices are inevitable for years to come? There is a strong case for historically high oil prices continuing for a number of years to come. But higher fuel economy standards, demographics, and oil substitutes will soften and perhaps even offset some of the upward pressure on oil prices. For example, IHS CERA believes that aggregate oil demand in developed markets peaked in 2005 and will not exceed that level again. Higher fuel economy standards adopted in American, European, and Japanese markets will steadily soften demand as more efficient vehicles enter the fleet. Also biofuel mandates will continue to dis-

* Graphic has been retained in committee files.

place oil products—principally gasoline. Lastly, aging populations in many countries—including China—is another factor that will tend to slow the pace oil demand growth. Looking further ahead, electric vehicles hold promise and may become increasingly competitive with conventional cars powered by internal combustion engines.

On balance world oil demand will continue to increase, but not necessarily at breakneck speed. Oil prices are likely to remain well above the levels seen during most of the past 30 years, but it will reflect a continued rise in global prosperity and also foster efficiency and innovation. There is no blueprint for the Global Redesign. There will, of course, be times of tumult. Energy prices, and especially for oil, will continue to reflect the shifting fortunes of the global economy and geopolitics.

The CHAIRMAN. Thank you very much. Thank all of you for your excellent testimony.

Let me start with a couple of questions, and Dr. Newell, can you just elaborate a little bit on your testimony about what is going to happen with the percentage of oil that we have to import over the next 25 years as you see it? I do think your testimony, it seems to be very different from what we have historically heard here in this committee, which is that imports have gone up and will continue going up.

This is consistent with what Mr. Burkhard just said, that the level of imports peaked in 2005? Is that your position? Maybe you could elaborate on that?

Mr. NEWELL. Yes. 2005 and 2006 were about the same, at 60 percent of overall liquid fuels consumption. It has come down since then, and a good part of that has to do with the economic downturn. When you have a decline in domestic oil consumption needs, that tends to come first out of imports. So, that is one of the things that has led to that significant downward shift over the last several years.

But we see that declining to 42 percent by the end of our projections. If you actually look at overall petroleum supply, which includes both imports as well as domestic production, that is about flat over our projection. But there is an increase in overall consumption of liquid fuels. That is being met by natural gas plant liquids, which are domestically produced. When you produce natural gas, you can get liquids out of that as well, which can displace conventional oil. Also biofuels, which increases in our projection.

There have been a number of different factors that have led to this change. One is more moderate consumption growth, which I could attribute to two factors. One is the increase in fuel economy standards that we have seen over the last several years, both for light trucks first and then for light-duty vehicles. We also have higher fuel prices, which leads to a market incentive for folks to choose a more fuel efficient car next time they go out to buy one. Same thing for trucks.

As I mentioned previously, on the supply side, we have an increase in natural gas liquids associated with our increased expectations for natural gas production, and we have the increase in biofuels due to the renewable fuel standards. So all of those factors together have led to a declining need for imports of oil.

The CHAIRMAN. Ambassador Jones, let me ask you, I think you made the statement that the growth in gas production or gas supply is having a downward or exerts a downward pressure on the price of oil? I thought I heard you say that. Could you explain that a little more? Are you talking about the fact that production of gas

does result in some gas liquids being produced and that is a factor, or are there other things going on there that we need to understand?

Mr. JONES. That was the thrust of my remarks. A lot of the shale gas plays in the United States produce the unconventional gas, are fairly wet and are producing more natural gas liquids. So natural gas liquid production in the U.S. has increased, which is one of the reasons why U.S. oil production hasn't gone down as rapidly as maybe some people thought it would.

That is true worldwide as well. Particularly in OPEC countries that are producing large amounts of natural gas, a lot of that gas is fairly wet, which means it has large amounts of NGLs mixed with it. The NGLs are separated out, and they are included in crude oil production or they are sold like crude oil.

In fact, the increase in OPEC NGL production is interesting because NGLs are not subject to the OPEC production restraints. So a country like Qatar that produces a lot of gas, producing a lot of natural gas liquids, can sell those, and it doesn't appear as part of its quota. But yet it has a real impact on the oil market. That was what I was referring to when I said it can help keep prices down.

The CHAIRMAN. OK. Let me just ask in general, you know, I think we are aware that this discovery of all this new natural gas in this country and now, more and more, in other places around the world has pretty dramatically changed the expectation for what the long-term price of gas might be. That, of course, impacts on decisionmaking with regard to new nuclear plants, with regard to renewable generation, with regard to a lot of things.

Dr. Newell, could you give us some insights as to what you see happening there?

Mr. NEWELL. Yes, that is correct. One of the implications of our reassessment of the shale gas resource base has been the significantly lower prices that we are projecting. So the average wellhead price of natural gas in our projection doesn't get above \$5 per million Btu until after 2020, which is significantly lower than what we had in previous years.

It gradually increases over that. But still, even toward the end of the period, it gets up to about \$7. You may recall a short time ago it was at least a couple of dollars per million Btu higher than that.

So the implications are that in the electric power sector, relative to other technologies, I mean, natural gas has had over the last decade or more several other advantages in terms of low capital costs, quick construction, and lower conventional pollutant emissions as well as lower CO₂ emissions, which aren't currently subject to regulation, but do enter into decisionmaking.

So, those other advantages that natural gas has, coupled with these now lower prices, do tend to tilt the balance even more toward natural gas. In terms of the capacity additions that we see in our projections, the majority of those new capacity additions are also for natural gas. The second-biggest source of new capacity additions would be renewables.

Another factor that is useful to keep in mind is we reassessed our power plant costs this year, and several of those went up. Some came down. Natural gas was roughly the same as what we had

been previously assuming. The overnight capital costs for nuclear and coal plants, which are much more capital-intensive—large, more complex projects—went up significantly, 20 to 30 percent. Renewables and wind went up a little bit, but not quite as much as coal and nuclear.

So, there have been a number of things that have changed over the last several years that tend to point to natural gas in the electric power sector. So we are projecting more natural gas consumption in electric power, particularly over the next decade, than we were last year.

The CHAIRMAN. Thank you very much.

Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman.

Mr. Newell, yesterday the Department of Energy released a finding stating that the construction of an oil pipeline out of Canada into the United States would reduce our dependence on Middle Eastern oil. Would you agree with the Department of Energy's findings there?

Mr. NEWELL. I have briefly reviewed the study that you are referring to, which was conducted in the context of the Keystone XL pipeline. Whether or not that pipeline exists, one question is whether or not the oil would be produced. That is one question. That study seemed to suggest that it would be produced regardless of whether there was a pipeline, and it would likely be exported to the west, to Asia, as opposed to south to the United States.

In terms of U.S. imports, that study concluded the oil would most likely come from Canada, rather than come from the Middle East, because we have had declines and are expecting further declines in heavy crudes from Mexico and from Venezuela, which have been historically sources of that crude oil. Because we have complex refineries that can use that heavy oil in the United States, we can refine this Canadian oil, and the most likely substitute would be Middle Eastern oil.

Senator MURKOWSKI. Then let me ask you in the reverse, our concern up north in Alaska is the continued viability of the Trans-Alaska pipeline, the TAPS. As you know, the throughput is declining to what we believe is dangerously low levels, and if we don't take some very serious steps in the very short term to add more oil into that line within the next few years, there is a real chance that it could be inoperable shortly after that.

So the question to you, and anybody else that might choose to jump in, is, the economic impact, the national security, the trade-related consequences that would result if we take TAPS Offline, and our Nation is in a situation where we are no longer receiving that 10 percent of domestic crude supply that we have been receiving for approximately the past 30 years.

If we lose a large-diameter pipeline like we have up north that brings crude into the lower 48, what is the economic impact of this?

Mr. NEWELL. I will just make a brief comment, which is that in our projections, the oil flowing through TAPS does continue to decline, as it has over the last several years. Toward the end of our projection, it starts to get to a level where my understanding is the pipeline would stop operating. Two hundred thousand barrels per

day is roughly my understanding, and it does get to that level toward the end of the projection.

So at least through the year 2035, we don't anticipate that it would close. But after that, clearly, that looks like it is on the longer-term horizon.

Senator MURKOWSKI. Let me ask about capacity because several of you have discussed this, and Mr. Diwan, I think you stated that it is your understanding that there is a relatively large cushion, was the term that you used, of about 5 million barrels per day. I am told that it may be 5. It may be 6.

The question is, and as we look to what is going on in Egypt and the uncertainty and the instability there, we look at what is available in terms of spare capacity and suggest, that can help insulate us from supply shocks, from the price shocks because we have got that spare capacity. How accurate do we really believe our numbers are when we are talking about this spare capacity? Do we really know? How verifiable is it?

Mr. DIWAN. We have a good idea. We don't have an exact number, and this is why I think we all hedged a little bit. It is probably closer to 6, but I like to say it is north of 5.

A large part of it is in Saudi Arabia. This capacity is new. It has been added in the last 3 years. So for once I would say that we know actually that there is a large amount of spare capacity available in Saudi Arabia. They have a production capacity probably close to 12.5 million, and they are producing 8.5 million.

So most of the spare capacity in the world is in one country, but that is the nature of what spare capacity is. It is a Middle Eastern concept.

Senator MURKOWSKI. Doesn't that give us less assurance. When we are talking about the concerns that we are seeing in the Middle East right now, to know that you have most of your spare capacity located in one country, what kind of assurance does that give us?

Mr. DIWAN. The problem with the concept of spare capacity almost is an oxymoron. Only certain countries are willing to invest to create capacity and not produce it. These countries are probably 5, OK, and they are all in the Persian Gulf.

This is their *raison d'être* almost geopolitically is to be able to provide that spare capacity if something happens. I don't know a single oil company in the world—Exxon, Chevron, any international oil company—which is willing to have capacity which is not producing. So the concept of spare capacity is focused on the Middle East at the end of the day.

So I have more assurance than I have 3 years ago that we know that Saudi Arabia did invest tremendously to increase capacity, and they have shown that they can produce more than what they are producing now. So, in a way, spare capacity as a number, I am more confident about it than I was 3 years ago because we have seen higher production numbers. We have seen a large amount of investment.

So is it 5? Is it 4? Is it 6? I don't know. But it is a large number.

Senator MURKOWSKI. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Wyden.

Senator WYDEN. Thank you, Mr. Chairman. Thank you to the panel.

I want to look at the issue of the role that the financial markets are playing with respect to oil prices. I was really struck—on Tuesday, the Wall Street Journal ran a column in what is called “Heard on the Street” that was entitled “Unrest Pits Oil Bulls Versus the Gold Bugs.” In effect, they were talking about which area made more sense to put your bets on. Should you put your bets on oil or gold?

Mr. Burkhard, you said something that I have not really heard witnesses talk about here in the Senate Energy in the past, and that is acknowledging the role that the financial markets are playing in oil prices with your statement where you say oil has become the new gold.

So my question, beginning with you, Mr. Diwan, you say that the big oil producers are not going to be affected by what happened in Egypt and Tunisia. I assume we are talking about the Saudis. My question to you would be do you believe that the recent price increases, like the \$5 a barrel increase in oil in a matter of days, do you think that is due to supply and demand?

Mr. DIWAN. No. Because we haven’t seen a supply disruption. But markets do anticipate. Correct? I mean, this is what they do. They want to price risk.

So the way I look a little bit at oil market, and I came here and in the House to talk about this financialization of oil in the last 3 years, money flows is like the steroids in the system. It comes, it rushes in. It has a very big impact. Sometimes it is lasting. Sometimes it is not.

Clearly, when you have a situation like you had in Egypt, people do try to cover or speculate or invest. But the broader question that you ask is how important are these financial players in the oil market? They are very important. Oil has become more than a commodity. It has become an asset class, and the last 3 years have shown that.

We have seen the money flow being the key determinant of short-term oil price changes. Does it determine the price is at \$90 or \$70? In the long term, it doesn’t. The fundamentals will. But these price movements, which are very jerky, have—I mean, I look very closely at oil prices, and most of the time, the only correlation we can have has to do with dollar value, with gold, with exchange rates, with equity rather than short-term moving the fundamentals. So the short-term moves are very much financialized.

Senator WYDEN. Over the years serving on this committee, I have walked away with the judgment that you usually don’t see a single factor dictating oil prices.

Mr. DIWAN. Yes.

Senator WYDEN. I don’t think you see just one. But clearly in past debates, I think short shrift has been given to this question of financial markets, and you just said this recent short-term increase was not due to supply and demand. That suggests to me that looking at the markets and the role of speculation is going to be increasingly important.

I think you touch on that, and you touch on that as well with respect to your views, Mr. Burkhard. So that takes us back to you, Mr. Jones, because you don’t think that the markets are really what this is about. You make it clear that you think this is about

supply and demand, that the price increases in oil recently have been driven by the situation in Egypt. Let me get you, so you can put it in your words what you think of what Mr. Diwan and, to some extent, what Mr. Burkhard have said.

Mr. JONES. The short answer is that I think I agree with a lot of what they said. I think that what my testimony was focused on was the actual run-up in prices since last September, and we saw a lot of tightness in the market. There was more demand.

The big news of 2010 was a more rapid resurgence in OECD country demand than was expected, and particularly in the last quarter. So, that is what got the prices moving up.

Now in the current situation where there is a crisis in the Middle East, as Mr. Diwan said, markets don't only look at what is happening today. They look at what they think might happen tomorrow, and that is where you get expectations in. So, I don't think there is necessarily a disagreement between us.

Senator WYDEN. If you look at your prepared testimony and you looked at Mr. Diwan's prepared testimony, there is a sharp difference. You play down the question of anything other than supply and demand. You are saying that markets are driving this, and the price of oil is driven essentially by the supply and demand question. Mr. Diwan is saying, look, we are not seeing any changes in supply and demand.

That is why I got into the question of financial markets. This is complicated stuff. We understand it. I am just concerned your approach gives short shrift to the possibility of speculation and the financial markets. Mr. Diwan, I think, puts it in the appropriate context that there are a variety of factors, but we shouldn't dismiss the question of markets.

When the Wall Street Journal is running articles talking about what you ought to put your bet on in the future, that ought to be a wake-up call that the Congress ought to start putting some attention on those issues.

My time is up, Mr. Chairman, and I thank you.

The CHAIRMAN. Senator Coats.

Senator COATS. Thank you, Mr. Chairman.

The CHAIRMAN. Welcome to the committee.

Senator COATS. I appreciate that. Because this is my very first committee meeting, I don't begin to have the experience or the background of my predecessors who have already spoken. So I am not exactly sure who to address my questions to, but I will let you decide who wants to respond.

Just two areas I would like to pursue. One is the energy security area. The gist of what was said here is that there seems to be a fairly high level of confidence relative to the flexibility of the supply lines and the capacity production and so forth. So an unrest or an interruption of supply, transmission of supply in one part of the world or from one source could easily be compensated for by increasing production or supplying through another area.

My question is, not going to the specific, but to the general, do you, like the military—does anybody “red team” these things? Do you have books on the shelf that say, you know, if this pipeline is shut down in the Caspians, this is what we ought to do, or this is where we should go? Is there a body of study and analysis that we

turn to when things like threats to the Suez Canal, threats to certain pipelines, political unrest somewhere in the world?

What is the level of analysis that has been undertaken, and what is the level of confidence that we can adjust to these kind of things? There is always this uncertainty out there about it is not factored in with conventional wisdom as to supply and demand and availability and price and so forth. I am not sure who needs to answer that, but Ambassador?

Mr. NEWELL. I will start, and then I will turn it over to Dick Jones. So, within the U.S. Government, the answer is yes. There is very good coordination within the Department of Energy, among different elements. The Energy Information Administration, which I head, works with the Office of Policy and International Affairs, which interfaces with the International Energy Agency.

We also work with the Office of Electricity Delivery and Energy Reliability, which, in the event of things like hurricanes or pipelines going down, tracks those events very closely. In fact, right now, they are focused on the winter storm issue in the Midwest because that has electricity ramifications.

In the current context of something like the situation in the Middle East, we are also in close contact with the National Security Council and other Government agencies, providing whatever analysis or background information that is necessary to help people understand the level of spare capacity on the supply side, which we have also talked about. Another issue that comes up when you are talking about, for example, Egypt, is different transit points. There is a pipeline called the Sumed pipeline which crosses there, as well as the Suez Canal. One thing to keep things in context, is that about 3 million barrels per day transits the canal and pipeline, but about 45 million barrels per day of oil moves around the world through marine transit. So, as a fraction of that, it is quite small. There is about 10 percent spare capacity currently available in marine shipping for oil. So, these are the kind of issues that we track very closely. In the event of some kind of a disruption, then the U.S. has a Strategic Petroleum Reserve which could be called upon, as well as other reserves. That is the context in which we then start to coordinate with the International Energy Agency.

So I will turn that over to Dick Jones.

Mr. JONES. Thank you very much, Richard.

Yes, just the IEA looks at the world, and we work with the world. We have 28 member countries. Obviously, the United States is one of the most important member countries that we have, but it is not the only one.

So when we are looking at the world situation, particularly if we see a potential crisis brewing or potential disruption, we begin consulting with the countries that would be the most likely to be affected. That would include the United States, but it wouldn't be limited to the United States. We do much of the same work that Richard was describing, we do internationally. We then provide information to our member countries to keep them abreast of developments in the situation.

Also I mentioned we have emergency response training exercises. Those training exercises are based on case studies, scenarios, and we don't make them up. We look at the real world and we say, for

example, if there is a disruption here. Then we let teams come from our member countries and from the nonmember countries, and we have several teams working on the same problem.

Then we see what they come up with, and we then debate whether or not this person's response or that team's response was the best one, or if there was one that was better and so on. That way, we all learn at the same time. We learn about the specifics of the issues, but we also learn about different points of view and how to work with one another, and that comes into quite a bit good use when we have a real crisis.

Mr. BURKHARD. One good example in the past that is instructive. In 2005, when we had Hurricanes Katrina and Rita, they took out a large amount of U.S. refining capacity. Gasoline prices went up in the United States, and that sent a market signal to the rest of the world to send gasoline to the United States.

So the flexibility of the oil market was important there, but also IEA members at that time, particularly in Europe, were offering their strategic gasoline reserves to the market, which also helped to calm it. So I think that very real, fairly recent example of market signals combined with the insurance, so to speak, of what the IEA members provide was a good example of crisis management.

Mr. JONES. If I could just add one thing? Our focus has been on oil because we were founded in the wake of the 1973–1974 oil crisis. But in recent years, we are focusing more and more on other forms of energy as well. So, for example, we now also are doing work on natural gas security, particularly pipeline security, which is very important to our European members, and we are also looking at electricity grids and how they can be made more secure.

So we are branching out beyond oil to natural gas and electricity. The response that Jim just mentioned was coordinated by the IEA.

Senator COATS. Mr. Diwan, did you have any comment?

Mr. DIWAN. No. I want to build on what Jim said. The market responds quickly. I mean, price signals change. When you have disruption some places, prices go and you arbitrage. The only problem, it takes time to transport oil.

So the system takes time to get back in shape, but we have seen it, crisis after crisis anywhere in the world, that you have enough spare refining, shipping crude. Right now, we have spare of everything that you can adapt. Just takes time because it is slow to adapt. You know, oil is bulky to transport and store and refine.

Senator COATS. Thank you.

Mr. Chairman, I want to get off to a good start with the Chairman. So I notice my time has expired and gone over time. So I won't ask my second question.

The CHAIRMAN. You set a very good example for this committee. We appreciate it.

[Laughter.]

Senator COATS. Thank you.

The CHAIRMAN. Senator Franken.

Senator FRANKEN. Thank you, Mr. Chairman.

I would like to welcome my new members—not my new members, the new members to the committee, of which I am one. While Senator Hoven was Governor of North Dakota, they discovered and developed tremendous oil resources there. In fact, some in

North Dakota say he created them. I would like you to come over in Minnesota and do the same, if you could.

But I want to turn to renewables because that is something we do really well in Minnesota. Dr. Newell, we need to be open to a diverse array of options as we think about energy policy. But as you say in your testimony, renewables seem to be where the largest growth is in the next 25 years. Is that right?

Mr. NEWELL. Yes, that is correct. They have by far the fastest rate of growth.

Senator FRANKEN. As I said, in Minnesota, we are a national leader in renewables, especially wind and biofuels. We are transitioning to renewables fast, largely due to policies like the renewable energy standard, 25 percent renewables by 2025. I am proud to say that Minnesota utilities met their 2010 targets under the RES.

In the EIA reference case scenario, we see a pretty bleak picture for renewables in 2035, only about 10 percent of our energy mix by 2035. Now I recognize that this scenario assumes no change in our national energy policies moving forward. Dr. Newell, what factors, in your view, both policy and other factors, could most help grow the U.S. renewables sector to a much higher percentage than those projections for 2035?

Mr. NEWELL. The key issues that have affected the growth in renewables over the last several years and that I would anticipate would affect it over the next several years are several fold. One is on the purely economic side, the cost of renewable technologies. Were those to come down from where we are currently forecasting, either due to faster innovation than we are expecting or additional research and development effort, that could bring those costs down, in which case they would be more competitive with other technologies for power, such as natural gas, coal, nuclear, and so on.

The other key policies that tend to support renewables are policies such as the production tax credit for wind, which does expire in our reference case, because that is what it does in current law. But you actually see a kink in the curve when it does expire. So that is clearly sending a signal that were it not to expire, that would have a significant impact, and we have run alternative policy cases that demonstrate that.

The renewable fuel standard for transportation fuels also has a big impact. But that is in our reference case and grows very considerably because that are under current statute and ongoing regulations that is already in law. So those are some of them. There are a number of other tax credits on solar and so on, which also expire at some point in time. Were those to—

Senator FRANKEN. I am sorry to interrupt.

Mr. NEWELL. Yes.

Senator FRANKEN. We have countries like China that are aggressively pursuing these, right, like solar and wind?

Mr. NEWELL. Yes. That is definitely correct. There are a number of European countries doing that and also particularly China has been investing heavily really in all sources of electricity production. They have phenomenal growth, and so they are investing in solar, in wind. They are also investing a lot in coal and nuclear. So they are really kind of all-out on all fronts.

Senator FRANKEN. Let me go to Ambassador Jones. I notice that you talked about three areas you would like to go—a strong push in efficiency, to decarbonize electricity, and create advanced vehicles.

So, let us talk about those. How do you decarbonize electricity?

Mr. JONES. I mean, promotion of renewables is one way to do that because they obviously don't burn fuel. But you can also—

Senator FRANKEN. They don't burn carbon? They don't add carbon?

Mr. JONES. They don't add carbon. But there are many other ways, and for example, you can have a coal-fired power plant running on biomass instead of on coal. You can have a coal-fired power plant with biomass and carbon capture and storage, and then you are actually taking CO₂ out of the air.

Senator FRANKEN. Right.

Mr. JONES. So there are a lot of different technologies that are available. The question is what is economic and what is appropriate to the political and the physical characteristics of the country? For example, a lot of countries are pushing ahead with nuclear power, and other countries have decided not to do any nuclear power for political reasons because of concerns, obviously, on nuclear proliferation, spent fuel, and things like that.

But there is a whole mix of approaches you can take, and we advocate a broad spectrum of technologies, depending on the endowment of the country. For example, some countries would be wasting their money if they invested in wind power because they just don't have the wind resources. Similar with solar power.

So we think that where it makes sense, a country should invest in renewables. Where renewables are not an option, they should invest in carbon capture and storage if they want to get the full lifetime out of existing power plants or use biomass to fuel those power plants, or they should invest in nuclear. It depends on the country.

Even in the same country, different regions will be different.

Senator FRANKEN. I know I am over my time. But I just want to say in summary that these projections to 2035, that is a fairly long way out.

Mr. JONES. Twenty-five years.

Senator FRANKEN. We can definitely—you say it, and you added a personal note, which is that we can do better. I would like to add the same personal note and just say that those three efforts—a strong push for efficiency, decarbonizing electricity, and advanced vehicles, which I assume mean electric cars, maybe LNG cars, anything else I am—

Mr. JONES. Hybrids—plug-in hybrids, all electrics. CNG is a possibility, especially for large transport, buses, and so on.

Senator FRANKEN. I thank you all for your testimony. Mr. Diwan, I just wanted to ask one last little thing? Did you, at one point, say “oil prices are a mystery to me?” Did I miss that in your testimony?

Mr. DIWAN. No. The more you know, the less you know after a while.

Senator FRANKEN. OK. That really made me feel good.

[Laughter.]

Senator FRANKEN. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Hoeven, welcome to the committee.

Senator HOEVEN. Thank you, Mr. Chairman.

Good to be with you. I would like to thank both you and Ranking Member Murkowski for holding this hearing today and say that I very much look forward to working with you on the Energy Committee and, of course, with our fellow members. Not only the Senator from our neighbor State, Senator Franken, but Senator Manchin and I go back, I don't know, 6 years or more working as fellow Governors, and worked on energy issues and worked through the National Governors Association.

So I very much look forward to working with you on these important issues, the energy challenges that face our country, and I see it as an incredible opportunity. Senator Franken was kind enough to refer to some of the progress we have made in energy in North Dakota, and we do produce a lot more oil and gas. We are over 100 million barrels a year now.

Ten years ago, though, we were not producing much oil, and we were, in fact, declining in our oil production. Frankly, oil companies, if they hadn't left the Williston Basin, they were leaving.

We worked very hard. Of course, a lot of the talk at that time was that companies weren't going to do exploration in the continental United States. They were still doing some great work up in Alaska, but really were going to other places around the globe for not only their exploration activities, but also production and refining as well.

So we worked very hard to create the right kind of business climate that would stimulate not only oil development, but other types of energy development as well. The clean coal technologies, renewables, wind, biofuels, we are making a lot of progress. It is not just about producing more energy that we ship to great States like Minnesota and other places—electrons, as well as oil and gas and biofuels—but it is very important for our economic growth and for job creation.

So I see that same opportunity for our country. My question to you is what should we do? What should this Congress do to stimulate energy development in all sectors? What is the most effective things we can do to stimulate energy development in this country across sectors, without picking winners and losers? I mean oil and gas. I mean electricity from coal, hydro, other sources. Biofuels, wind, nuclear, you name it.

But across all sectors, what are the things that we can do that will be most effective as a Congress to stimulate energy production in this country? I would particularly like you to focus on nonrevenue measures because we find ourselves with a bit of a budget challenge these days. So particularly the measures that don't cost money.

So I am not talking about direct subsidy and so forth, but the kind of legal, tax, and regulatory measures we can put in place to stimulate energy development most effectively. I would like each of you to respond to that, if you would?

Mr. BURKHARD. I will start off. I will steal a phrase from a book of our chairman Dan Yergin. When Churchill 100 years ago switched the Royal Navy from coal to oil, he said security is in di-

versity and diversity alone. So in terms of pursuing different strategies, a singular approach probably isn't the most appropriate fit, but multidimensional policies that focus on supply and demand.

Some of the trends and places you alluded to, Senator, if they continue, they will help both on the demand and the supply side. North Dakota is one of the key reasons why in 2009 the United States had the greatest increase in oil and gas production anywhere in the world. The United States did in 2009. In 2010, that growth trend continued, and that is due to what is happening in North Dakota, but also Pennsylvania, other relatively new players on the oil and gas side.

In terms of continental energy security, let us not forget about Canada. When we think of foreign oil, we think of something distant, far away, unknown. I don't think of Canada that way. Twenty-one percent of our oil now comes from Canada. It is by far the biggest oil supplier.

So thinking about continental energy security, if the same trends in oil and gas continue, that will play an important role. On efficiency, the fuel economy standards that were renewed, strengthened in 2007 and then again in 2009, I believe, they are going to play a very large role in keeping U.S. oil demand below the 2005 peak.

So I think consistency in the long-term approach and a multi-dimensional approach on demand and supply is something to consider.

Senator HOEVEN. What percent of our petroleum consumption is provided by the U.S. and Canada together? Do you know?

Mr. BURKHARD. Canada is about 2.5 million barrels per day. U.S. oil, it is roughly probably half. Maybe a little bit more, the U.S. and Canada combined total.

Senator HOEVEN. But of our total consumption, of our total consumption, what percentage do we cover between the U.S. and Canada? It is higher than people realize, right?

Mr. BURKHARD. It is probably half.

Senator HOEVEN. Fifty percent?

Mr. BURKHARD. Maybe a little bit more, 50 to 60 percent. If you include Mexico, it is even higher. If you look at North American energy security meaning Mexico, Canada, the U.S., you are looking at 70, 75 percent, something around there.

Senator HOEVEN. Seventy-five percent.

The CHAIRMAN. Anybody else have a quick answer, and then—

Mr. DIWAN. No, I just wanted to point to a slight contradiction.

Senator HOEVEN. If you want, you can say the top 3 things so I don't violate my timeline. But—

The CHAIRMAN. Yes, we have gone over the time.

Senator HOEVEN [continuing]. Name 1, 2, or 3 things that would really make a difference, in your opinion.

Mr. DIWAN. The cheapest barrel of oil is an efficient car, all right? I mean, this is how you reduce your demand, and it is probably cheaper than producing a new barrel of oil.

But I just wanted to point a slight contradiction. I mean, if North Dakota has seen its production increase, and it is a great thing, it is because we have very high oil prices. So it is the economics which are answering. We always knew about the reserve in the

Bakken, but they were never economical. When prices reach a certain trigger, technology was able to come and change that supply function. So having \$3 gas and having high production in Dakota goes together.

Senator HOEVEN. No question, but the new technologies were vital and will continue to be vital in order to produce it economically—

Mr. DIWAN. Absolutely.

Senator HOEVEN [continuing]. Even down to a barrel price of maybe \$50 a barrel.

Mr. DIWAN. Absolutely. So, efficiency, technology, and I would say a regulatory framework, which is look at the long term and allow the diversification across energy sources.

The CHAIRMAN. We have two Senators here who haven't yet asked their first round, and then we will come back around, and we can get more response to that in the second round perhaps.

Senator Udall.

Senator UDALL. Thank you, Mr. Chairman.

Good morning, gentlemen. Thanks for being here today.

Let me start by speaking to the profits of the oil companies. It has come to my attention that Exxon just announced that its profits for the last part of 2010 were over \$9 billion. It is a 50 percent increase from earlier in the year. Exxon is not alone. Most, if not all the major oil and gas companies are going to report huge profits for 2010.

Mr. Diwan and Mr. Burkhard, what will the major U.S. oil companies like Exxon do with these record-setting profits? For example, how much of those net profits would you estimate that the major U.S. oil companies are investing, or will invest, in domestically produced clean and renewable fuels, the price of which are not set by OPEC?

Mr. BURKHARD. I think some context for that, one, oil companies are price takers, not price makers. The revenues reflect the global oil markets. In terms of their spending, oil companies, the very large oil companies, their capital expenditures in a given year can range from roughly \$15 billion to \$25 billion.

So it is a treadmill that they are on to constantly reinvest because they have fields that are at plateau production or declining. So it is a massive capital-intensive business where you have \$15 billion, \$20 billion, \$25 billion of CAPEX are what we are seeing right now. A lot of these companies are part of this what we call "the shale gale," the unconventional gas revolution in the United States, and gas is a lower carbon content fossil fuel. So that is playing a big role.

Senator UDALL. So you see them moving some of those profits into development of gas reserves?

Mr. BURKHARD. Yes.

Senator UDALL. Mr. Diwan.

Mr. DIWAN. I mean, they are oil and gas companies, first and foremost. So they invest in oil and gas.

If you look at the broad trend in terms of capital flow, the United States has seen a lot of investment. The global industry is coming back to the United States, and that is a big development over the

last 2, 3 years. Obviously, it has to do everything with the shale gas, but also the onshore oil potential in places like the Bakken.

So the United States, because of technological change and the high oil prices, have been able to attract a lot of capital. A lot of these oil companies who have been looking abroad for years to be able to add to their reserves are coming back to the United States.

They are not the most nimble companies. They are very large. So they tend to be second and third movers, rather than first movers. The small companies, the muscle, the economic muscle here have already created the resources. Now the oil companies are going to develop them.

In terms of their investment in other technologies, it is really research and development. They are not biofuel companies. They are not solar companies. They will not become solar companies. So they are what they are.

Most of their investment go back into massive projects where the treadmill that Jim is talking about is very important. The decline rates are very steep in the oil fields that they bring. They are probably 10, 15 percent, sometimes north of that. So, in a way, these companies are constantly seeing their base resources disappearing. So they need absolutely to invest, and that treadmill is only getting faster.

Senator UDALL. So you see them playing an important role in continuing to produce secondary, tertiary oil from such fields. But the advances in biofuels and clean energy will come from other sectors as well and from other entrepreneurs, other businesses, other business models?

Mr. DIWAN. I think so. I mean, that is the model. These companies are not the most nimble for these things.

Senator UDALL. The demand for oil is driven mostly by our transportation sector. I think, what, 70 percent of domestic oil demand.

I am directing this at the panel. Do you have a sense of what percentage of our transportation sector would have to be fueled by electricity, natural gas, or some other alternative fuel in order for us to achieve energy independence in the transportation sector? In other words, at what point could our domestic supply of oil fulfill our domestic demand?

Ambassador Jones, if you want to take that question for the record, too, I would be more than happy to work with you.

Mr. JONES. I don't think it is something that we have actually sat down and tried to calculate. You could probably do a back-of-the-envelope calculation in terms of imports and how much share they are and figure it out. But Richard, you might have done something? I don't know.

Mr. NEWELL. Yes. We have not analyzed that particular question. But under existing laws and market trends, while there is a decline in net petroleum imports, it is still quite sizable even 25 years from now. If one imagined what would be the kinds of actions that could change that, one would be declining consumption because declining consumption tends to come first out of imports.

Then, substitution of the remaining consumption toward something that is not imported, which if it is electricity, electricity tends not to be imported. So any domestic source of electricity would do that. If it was domestically produced biofuels, that would do that.

But one would have to analyze a particular proposal in order to—most anything you look at is potentially achievable. It depends on what kind of actions one is willing to take to achieve it.

Senator UDALL. Thanks to the panel.

The CHAIRMAN. Senator Manchin.

Senator MANCHIN. Mr. Chairman, thank you. Thank all of you for being here.

I am sorry. Some of us had to go back and forth to committee meetings. So if I repeat something or might have missed something, I am very sorry for that.

The State of West Virginia, as you know, is an energy producer, always has been for many, many years. We just have a hard time understanding without an energy policy in this country and what you just told us about, the dependency we are going to have on foreign oil, the security of the Nation being at risk because of our dependency on foreign oil, the uncertainty in the Middle East right now, and the growing uncertainties that could even make us more vulnerable, and our economy, how it is tied so tight, and you are telling me our dependency will grow and not become more independent.

In our little State, we have an energy portfolio. We try to use everything we have. We have developed our shale gas, natural gas, as you know, in the Marcellus shale. We have a tremendous abundance of coal. We have biomass. We have a tremendous wind operation in West Virginia, which very few people know, and we have done everything we could with hydro.

What I don't understand is that of all the energies you are talking about, there are subsidies, and I think that is what the Senator from Colorado was talking about. The subsidies of energy, whether it would be to oil, gas, wind, solar, biofuels, ethanol. The only energy source which is the greatest source that we have as far as we are dependent on right now is coal. It doesn't get a penny of subsidies.

But it has been villainized by this administration and so many people, and it is the one we depend on the most that gives back more than what it takes. I can't figure it out.

I mean, we are trying to use it in so many different forms, in supercritical heating and things of this sort. We are running into roadblocks with the EPA from every turn that we go. We are trying to use it in conjunction with our natural gas productions and trying to look at the changing and the fleet, especially our commercial fleet to compressed natural gas I think is a very doable.

Do you all have a comment on why that one source of energy, which is the most depended upon in this Nation, has no types of subsidies, but the others demand so much subsidies? Does anybody want to answer that?

Mr. NEWELL. I guess I would just say that Congress makes these policies, and so I don't have any particular—

Senator MANCHIN. Do you all have a comment? Basically, do you think it is kind of off balance that 50 percent of our energy comes from the coal, which we have depended on for hundreds of years. No subsidies, not one penny of subsidies.

But then oil—and I heard the profits of, what, \$9 billion of profits—and the subsidies from that, subsidies from the tight sands of

natural gas, subsidies on a gallon of ethanol, and everything else. Does it not make a little bit of—

Mr. NEWELL. The one remark I will make is that we have been requested to do an analysis of energy subsidies by the House, and that is underway. We will be issuing that report sometime in the next few months.

Senator MANCHIN. You compare that toward the coal that gets no subsidies. Will you compare it against what type of energy this country receives and depends upon without any investment except the market forces?

Mr. NEWELL. Yes. It is a broad study that covers all manner of energy subsidies.

Senator MANCHIN. The dependency that we have had on foreign oil and the uncertainty in the Middle East, I know you all have talked on that a little bit. I have noticed, Mr. Newell, you have talked about the price of a barrel of oil and the uncertainty, not really knowing where it is going. What do you anticipate as far as we, as a Nation, are able to take care of the dependency, independency as far as from our own domestic production? Is there any of you believe that we can become independent with the current policies?

Mr. BURKHARD. Senator, just on the coal question, I am not an expert in subsidies. But what is perhaps little noticed in some areas, the last decade, the strongest energy source in terms of demand growth has been coal around the world. That is due to what has been happening in China and India.

China, India, and the U.S. are among the top resources—

Senator MANCHIN. The rest of the world is using it more, and we are villainizing it more.

Mr. BURKHARD. It is a cornerstone of global energy supply in this country and certainly in China and other major players.

Senator MANCHIN. Do any of you all believe that we can become energy independent?

Mr. DIWAN. Why do we need to become energy independent? We are not independent of pretty much anything. We believe all in free trade. We all have Italian ties, Chinese shirts, Chinese computer chips in our computers. We import everything, and we export everything. Oil shouldn't be that different, and energy in particular. So—

Senator MANCHIN. You don't believe that we should try to become—

Mr. DIWAN. I don't think it is a key issue. It is a global commodity. It is globally priced. If we can import it, we can import it.

Senator MANCHIN. Do you all believe that it ties to the security of the Nation?

Mr. DIWAN. It has a security aspect, but it is not the only one. There is an economic aspect.

Senator MANCHIN. Sure.

Mr. DIWAN. What it costs to fuel this economy is a key issue.

Mr. BURKHARD. I would just add energy security and energy independence aren't—you know, there are differences between the two. If energy security is the objective, that may lead to different outcomes, different decisions than energy independence.

Senator MANCHIN. Basically, those of us who lived through the 1974 oil embargo and saw what it had done and how it crippled the Nation, and at that time, I think we tried to take the position we would be energy independent by a very short period of time, by 2000. Of course, that came and gone.

So you all are not tying the security of this Nation toward the independency that we could do with more domestic production of all of our resources?

Mr. BURKHARD. The increase in continental production, in Canada and the United States, it has been a source of economic growth in the places where it has taken place. So it is important in job creation, and it does play an important role at enhancing global energy security and, consequently, U.S. energy security. The growth in U.S. gas production and oil production is an important component of that overall security story.

Senator MANCHIN. I will save that for a second round. Thank you, sir.

The CHAIRMAN. Senator Coons, welcome to the committee.

You are the only one here now who hasn't asked a first round of questions. Did you have questions you want to ask in this first round, and then we will do another 5-minute round?

Senator COONS. Thank you, Chairman Bingaman and Senator Murkowski.

I am grateful for the opportunity to join you. I apologize for my lateness. As is so often the case, there were other committees. Judiciary Committee just reported out an important patent bill that I think will help contribute to the role that I also view this committee as having a central place to play in, which is sustaining America's leading role in innovation and then making sure that we work together to develop the energy technologies of the future.

I was interested in the testimony of several of the members of the panel. Dr. Newell, what changes do you expect to see going forward that are based on energy efficiency?

I may have missed that since I was not here. But in what I read I didn't see a clear trajectory on what we could achieve in terms of savings due to energy efficiency standards. As that is something we expect to take up shortly, I would be interested in your views on how important that might be to America's energy future.

Mr. NEWELL. Sure. Thanks for that question.

When we look out over the next 25 years, there is a substantial decline in the growth of energy consumption we expect to have from the historic situation for a number of different reasons. If one looks at structural change in the economy, there is a significant change toward a more service-oriented economy, which tends to moderate the rate of energy growth.

We have done some analysis that suggested our consumption is going to be a third lower simply because of structural changes in the economy, which lowers the overall energy intensity of the economy. We have also done analysis that looks at changes in the energy efficiency of particular technologies, and that further lowers energy consumption about 13 percent from where it otherwise would be. That is already built into the reference case projection that I mentioned.

Now those changes in efficiency come from a number of different places. One is efficiency standards that have already been promulgated or that manufacturers and the Department of Energy have agreed to. There have been some recent standards there which are built into our forecast.

Market prices also play a role in reorienting consumers toward more energy-efficient appliances. You also have voluntary programs like the Energy Star labeling program, which provide information to people to help them understand what the energy consumption is from their appliances. These also tend to affect consumer behavior.

In terms of disentangling the effect of these difference pieces, it becomes quite complex. I mentioned some of the things we have done. The other thing that enters in is fuel economy standards for automobiles, which I mentioned.

We do include in the reference case the standards through the year 2016, which get the fuel economy of the light-duty vehicle fleet up to 35 miles per gallon. But in our reference case, fuel economy actually continues to grow beyond that up to 38 miles per gallon by 2035, purely due to market incentives.

So once these technologies are built into automobiles, the next time a manufacturer introduces a new model, those new technologies would tend to be included in those new models. Given higher projected oil prices, that would tend to provide an incentive for consumers.

So there are a number of different policy and market incentives that are directing the economy to more energy efficiency. Although energy consumption still grows, it grows by a significantly lower rate than what we have seen historically.

Senator COONS. Thank you. If I could, one other question to Ambassador Jones?

You expect electric and plug-in hybrids to make up to 70 percent of new car sales in 2035, if I am not mistaken, under one of the scenarios. Tell me what technology developments you think are critical to achieving that, what policies we should be pursuing to help ensure an American leadership role in that, and what are the different policy scenarios that you think would deliver the biggest advantages for us in terms of deploying that fairly significant percentage participation?

Mr. JONES. I think the technology that needs the most work on is battery technology, storage. Increasing the energy density of batteries to allow the vehicles to have greater range. One of the key points that people always raise with electric vehicles is their lack of range, the fact that the speed with which they can be recharged, how often they need to be recharged.

Now, in point of fact, studies have shown that, for example, BMW is developing electric vehicles, and they brought a fleet of electric BMWs and they let people drive them for a year, and they followed their use. They actually found that most people didn't really need to recharge their car more than 2 or 3 times a week, and it was very easy. After a few weeks, they realized this, and they liked the vehicles.

But there is a lot of acceptance, that public acceptance is the real problem. But that can be overcome with better battery technology,

cheaper battery technology. But that is the key thing. Most of the rest of it has already been developed.

Senator COONS. Thank you very much.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much.

Why don't we do our second round here? Senator Murkowski, did you have questions?

Senator MURKOWSKI. Yes, thank you.

Mr. Newell, I want to confirm that within your projections, you do not include any assessments as to Alaska natural gas being part of the mix within the projections through 2035. Is that correct?

Mr. NEWELL. Yes. That is correct. That tends to depend heavily on the Alaska natural gas pipeline.

Senator MURKOWSKI. Yes.

Mr. NEWELL [continuing]. Our assessment is that the capital costs have increased, and domestic lower-48 gas prices have come down. So, that pipeline through—at least through 2035—is not currently in the projection. That is correct.

Senator MURKOWSKI. I just wanted to confirm. Let me ask more generally then, in terms of your assessments as they might relate to the Arctic as a whole, not necessarily just to the U.S. Arctic and what may or may not develop offshore there, but as you know, we have the BP-Rosneft deal that is at play in the Arctic.

Do you include these prospects in your assessment, either the BP-Rosneft deal or just anything in the Arctic? I think we recognize the potential for the reserves up there, but do you anticipate in your forecasts seeing anything coming out of the Arctic?

Mr. NEWELL. I would have to go back and look at the specific results that we currently have. But areas that are open for lease sale would enter into our projections at some point. There have been changes over time in terms of what areas, at least around Alaska, have been open. I think that has even recently changed. So I would have to go back and see exactly. But, yes, we do assess those areas for sure.

[The information referred to follows:]

The Energy Information Administration's global liquids production projections, as published in the Annual Energy Outlook 2011, reflect oil production in offshore Alaska but not in Arctic regions other than Alaska, and therefore do not include any production potential as a result of the BP-Rosneft deal. Although oil is already being produced offshore in the Alaska Arctic, additional oil production from undiscovered offshore fields is not projected to commence until after 2030. In the Annual Energy Outlook 2011 reference case, oil production from new Alaska offshore fields in the Arctic reaches 200,000 barrels per day in 2035.

Regardless of the EIA projections, Shell Oil is making a concerted effort to drill exploration wells in both the Beaufort and Chukchi Seas. If Shell found sufficiently large oil reservoirs at either location that would justify their commercial development, then new offshore oil fields in the Alaska Arctic could be in production by 2020.

Senator MURKOWSKI. Let me ask, a question for the whole panel. We talk a lot about the reserves worldwide and what the U.S. consumes. The commentary is that the U.S. consumes a quarter of the world's oil, but we only have 3 percent of the world's reserves. I have some issues with how this is stated.

First of all, the 3 percent figure, as I understand it, only speaks to proven reserves, which is to say that they have already been drilled there. It doesn't reflect any of the unexplored areas, wheth-

er we are talking Arctic offshore or whether we are talking Atlantic, Pacific coast, Eastern Gulf, much of the deep water.

So I guess the question to you all would be, first, how important is it to actually know what our oil reserves amount to? Secondly, if we here in the United States were to prove up our reserves, not use them for production, but just provide for that assessment, and we were to do so within the next 5- to 10-year horizon here, what does this do to the percentage of global reserves that we know in terms of our percentage of consumption here in the United States? How does that even out? Again, I am curious to know how important is it to know exactly what we have in terms of reserves?

Mr. Burkhard, why don't we begin on your end?

Mr. BURKHARD. Reserves are an important figure, but there is no global, uniform standard that countries around the world adhere to. So it is a figure that is used a lot, but it has an uncertain definition globally.

One quick example, the Canadian oil sands. If you include the Canadian oil sands, Canada has the second-largest oil reserves in the world after Saudi Arabia. If you don't include the oil sands, which some don't, it falls down quite a bit.

Perhaps a more relevant example of the resource bases is production as opposed to reserves because the reserves depend on future investment and activity and fiscal terms, a whole host of factors. The U.S. is the third-largest oil producer in the world, and it is the largest gas producer.

Senator MURKOWSKI. But what you are saying is we don't have a uniform definition as to how we are defining reserves, and that doesn't allow us to do an apples-to-apples comparison. Is that correct?

Mr. BURKHARD. U.S. companies do adhere to a common standard, but—

Senator MURKOWSKI. Right. But outside of the United States?

Mr. BURKHARD. Right.

Senator MURKOWSKI. Mr. Diwan.

Mr. DIWAN. Yes. I mean, in some places, it is a political number.

Senator MURKOWSKI. Yes.

Mr. DIWAN. In other places, it is an economic number. At different prices, you have more or less reserves. At \$100 oil, you have more reserve than at \$10 oil because you can exploit these resources and move them to reserves.

So I think, overall, it is not a key criteria. When you look at oil companies, their reserves always seems very limited. I mean, the United States has basically 10 years of reserve ahead of us for the last 50 years. So it is not a completely meaningful number. There is definitional issues, and it is also how we prove and how you book reserve, which is another factor which is complicating.

Senator MURKOWSKI. Is there an effort within the EIA that takes what you have globally and tries to come up with a commonality and looking to not necessarily redefine, but to just make sure that you are doing a same comparison when it comes to understanding what the global reserves are?

Mr. NEWELL. For the United States, it is, I think, relatively well defined in the global sense. But we have been asked on other occasions by other Members of Congress to try and dissect and put on

an apples-to-apples basis, as much as is possible, and we can share that with you.

It is a challenge. We rely on sources, as others do. The U.S. Geological Survey is very important in this area, the Oil and Gas Journal also. But as was stated, you have to treat different estimates from different places with different degrees of surety.

To get to your question, I think in terms of how it would impact, for example, the work that EIA does, the thing that matters most over a 20-, 30-year time horizon is even beyond reserves. Because as was mentioned, reserves only prove up maybe a decade or so of production. Beyond that, it is the technically recoverable resource base that becomes even more important. But reserves are important in the near term because they speak to areas that companies have demonstrated and taken the effort to say that they can produce economically under current prices and technological conditions. So it is relevant for near-term projections.

I think from the grand scheme of things, if one was to more carefully assess the U.S., it could change. In terms of the global balance, though, I think it is unlikely to change in terms of sheer magnitude just because so much of both reserves, and then also beyond that, recoverable resources, are outside of North America. I think that basic high-level U.S. context would not change significantly based on that.

If I may just say one thing to respond to a couple of questions posed earlier? Is that—

The CHAIRMAN. Yes, go right ahead.

Mr. NEWELL. One minute. Senator Hoeven had asked what percent of our petroleum consumption comes from Canada and the United States. The U.S. is the source of about 48 percent of our liquid fuels consumption, and Canada would add about another 12 percent. So you would get up to 60 percent if you added those 2 together.

The other thing for the record I just want to state is that my tie is hand-tailored in the United States of America.

[Laughter.]

The CHAIRMAN. You are a rare individual, but we are glad to know that.

Senator MURKOWSKI. Thank you.

The CHAIRMAN. Senator Portman, you have not had a chance to ask any questions. All of us have had at least one round of questions. So why don't you go ahead with your questions? Welcome to the committee.

Senator PORTMAN. Thank you, Mr. Chairman. I appreciate your welcoming me, and it is good to be here with a few of my colleagues.

I apologize that, as a new member, I am still trying to figure out how to be at 3 different hearings at the same time. In this case, I didn't get the chance to hear all of the interesting testimony. I did read some of it.

I hope this question is not one that has already been addressed, but my focus would be on the economy and the impact of your prediction of increased demand and, therefore, increased cost of oil. I looked at some of your data indicating that we are going to be ap-

proaching \$100 a barrel in the next couple of years if your projections are correct.

I know we are not looking at the economic analysis here as much as pricing and supply, but have you looked at the impact on U.S. economic growth during that period, assuming that your projections are correct on the increased cost of oil?

Although we are producing a lot domestically, as you just said in response to Governor Hoeven's question, obviously, as Egypt and other countries experience issues that affect the cost of oil, what will the impact of that be, and has that been calculated into your projections on the cost of oil over the next couple of years?

I open it up to any and all of our witnesses today.

Mr. NEWELL. Sure. I can respond. Both our short-term and our longer-term outlook really take assumptions of both U.S. domestic and global economic growth as an input into that analysis, but it does take account of oil prices within that. One question is if there were to be changes in oil prices, what could be the potential ramifications for the U.S. economy?

This is a complex question, but let me give some thought to it. Other things equal, every \$10 per barrel increase in the price of oil tends to add about \$40 billion per year to our oil import bill. Since imports are subtracted from gross domestic product, this tends to weigh on gross domestic product. So every \$10 per barrel increase in the price of oil may lower GDP by 0.2 percent or so. That is one way to look at it.

Now a key issue, though, is what is causing the price increase? If it is demand-side economic growth that is causing the price increase, along with that economic growth—which may be coming from abroad—our exports may be increasing because China or other countries may demand more materials, more equipment from us.

So, demand-side increases in prices can be consistent with continued global economic growth. The place that tends to be more of a concern is if it is a supply side shock to oil that causes prices to increase, which pretty unambiguously tends to be a more significant headwind for the economy.

The one other point that I will mention is it also depends upon the state of the economy into which this oil price change is entering. If you are in a situation of a weakened economy or if you are in a situation where things like monetary response would not be sufficient, then you could be in a more problematic situation.

Our sense of the current situation is that a lot of the price increase right now is demand driven, and so that is consistent with continued economic growth. We don't see that, at least at this point, providing a significant headwind for the U.S. economy.

Senator PORTMAN. I noted in your testimony you also, though, said that the demand side dynamic here is driven primarily by emerging economies. You cited China and India and Brazil. So, our experience certainly in the last couple of years is, is those countries have increased their economic growth and have continued to grow. It hasn't reflected on a change in our balance of trade in terms of the export-import issue you talked about or our economic growth certainly in 2009, going into 2010.

But I appreciate your answer, and I hope that these very important energy inputs are being taken into account as we look at what the economic forecasts are going forward. Any other responses from the panel?

Mr. BURKHARD. Very briefly, it is an excellent question, tough to answer because there is no magic price that elicits a response on the part of consumers or governments. Certainly, there are psychological points. When oil hits \$100, when the price of gasoline hits \$3, or if it were to go up to \$4, you will see the higher it goes, the stronger the reaction will be.

But that is in the United States, but oil is priced differently, different areas around the world. Some consumers are shielded from high prices, others exposed to it. So the reaction globally is very uneven.

Senator PORTMAN. Any other responses?

Mr. JONES. Yes, just picking up on the global response, I mean, a lot of countries are less well positioned than the United States to handle high prices, and they are price takers. It will have an impact on their economies.

I mean, I had a chart in my testimony where I talked about the oil burden. Basically, at \$100 oil, you are getting up to about 5 percent of world GDP going for oil imports. In the past when that has happened, it has been a harbinger of a recession.

Whether or not it would occur this time, nobody knows. But if that price were sustained for all of 2011, we would have concerns of the economic impact.

Mr. DIWAN. There is one last element which is important, which is the value of the dollar. Because a lot of countries pay for oil in dollar, and if dollar is rising or the declining also have an impact into that equation.

Senator PORTMAN. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Wyden.

Senator WYDEN. Thank you, Mr. Chairman.

Mr. Burkhard, I want to continue this line of questioning that I began with the whole question of financial markets and what is going on in the Middle East and this time turn to the question of oil that is now in storage. If you take a look at the EIA figures, the Energy Information Agency figures on inventory, what they show is there are people out there who have been holding a lot of barrels of oil in storage significantly above the normal inventory levels, sometimes tens of millions of barrels.

Now, through the summer, as the prices climb, the petroleum in storage also climb. When the oil was sold off at the end of the year, prices dipped. Now we have this whole array of immense challenges, obviously, in the Middle East. Mr. Diwan said that that is unlikely to actually impact oil supply, but oil in storage is rising again at levels well above normal inventory levels.

So my question to you is break down for us what all this buying and holding and storage is all about. Because it suggests to me, picking up on the theme that you touched on earlier, oil in storage is also part of the oil as new gold, which is going to be driving investors staking out positions in the years ahead that brings a new

element of speculation into this debate that we are going to have to concentrate on.

So break down for me what you think this set of changes in storage is all about.

Mr. BURKHARD. Part of the oil storage story over the past year is investors, companies are responding to market signals because the oil market in the U.S. has been generally in a state of contango. Now, what the heck is “contango”?

Contango is where the price to buy a barrel today is let us say it is \$90. In the futures market, it means that 6 months from now, a year from now, that price could be \$95 or \$100. So that means if I buy a barrel of oil today at \$90, I lock in the price to sell it at \$95, 6 months down the road, I can lock in a return.

So, investors have been responding to that contango environment in the oil price. What it is generally signaling is the market’s expectation that supplies, oil supplies will be more valuable in the future. So buy today will pay you more later because the market thinks it will be more valuable.

One of the drivers of that—not the only one, but an important one—was last year, in 2010, we saw the second-largest increase in oil demand globally in more than 30 years. So this sense that the oil market will become tighter over time is one of the factors that explains the behavior in this contango-type environment.

Senator WYDEN. We are going to have to get into contango because I will tell colleagues—Senator Murkowski, I don’t think you were here when I laid out this point that the Wall Street Journal talked about. At the beginning of the week, they ran their “Heard on the Street” column that had a title “Unrest Pits Oil Bulls Versus the Gold Bugs,” basically making the discussion for the future essentially where people are going to make their bets.

Obviously, these issues with respect to how oil and gas prices get set are complicated, difficult kinds of questions. But to me, these questions that are finally making the pages of the Wall Street Journal are ones that have gotten short shrift, and that is why I think Mr. Burkhard, Mr. Diwan have given us a lot of valuable information.

Mr. Jones, I appreciate your moving toward Mr. Diwan’s position because when I read your prepared statement, I saw a sharp difference between what you were saying and what Mr. Diwan was saying that, to me, undervalues how important this financial market issue is going to be as we try to get into these questions.

Mr. Chairman, I thank you for this additional round because I think oil in storage represents yet another iteration of what Mr. Burkhard calls the new gold because this is going to be part of what drives the debate about financial assets and where they are headed in the future and one I certainly am going to spend a lot of time on.

So I thank you.

The CHAIRMAN. Thank you.

Senator Hoeven, did you have additional questions?

Senator HOEVEN. Thank you, Mr. Chairman.

This follows a little bit on my earlier question. You talked about looking at supply in this country in a continental way with Canada and Mexico, talked about efficiency, talked about technology. Of

course, Mr. Diwan said, well, you know, price drives that. That is important and true in many respects. It is interesting, though, once that technology is out there and deployed, of course, it tends to bring down the price at which you can produce oil or gas or most any other energy at a lower threshold, which is very important for our production going forward.

So, with that in mind, I want to ask and maybe start with Mr. Diwan because, I mean, obviously, it is price driven. But we need to find ways to deploy technology that helps us produce more energy in environmentally sound ways and work to bring that cost down. So how do we do that? Maybe talk in terms of countries around the world that are doing some things that we should be looking at doing, and I am really talking from the production side.

Most of your projections you talk about the demand side, which I understand. China's incredible growing demand, India, so on and so forth. But from the production supply side, talk a little bit about that. Who is doing things to produce more? Who is using technology in new and innovative ways that is going to really have an impact going forward and, again, something that we can look at?

Mr. DIWAN. The good news here is really the bright, shiny example of how economics work and incentive works and price works is the United States. What we have seen in the United States over the last 5 years is phenomenal.

Gas prices increased, and this increase in gas prices have triggered a technology called breakthrough. We knew about the shale gas. We had an idea a little bit how to go about it. But what happened in the United States in terms of breaking the code, if you want, and being able to produce that gas and now extending that technology to oil is just phenomenal.

Most oil companies, the large oil companies, the large national oil companies drill very few wells every year, and they tend to do a lot of experimentation in labs, et cetera. In the United States, it is very different. You have a very large entrepreneurial sector, both of oil companies and service companies. They don't go into labs and think about 3 years how we are going to drill that well. They go and they drill it.

The wells are fairly small. The investments are fairly small. Capital is available. Risk capital is available. They basically try and try and try.

What we have seen in the gas world is we brought all these ingredients together—capital, technology, experimentation, resources—and we broke the code of the shales. That has tremendous application globally, and that what we have seen since is because of that, the natural gas supply increased, gas prices went down. So you have that surplus of capital, technology, people, material, wells, et cetera, and it shifted to oil. This is how we have seen now this tremendous development in onshore oil in the United States, which was a dead sector 10 years ago, and it was perceived as a dead sector with very little future.

A year and a half ago, we were talking about what is happening in the Bakken. Now we are talking about what is happening in the Eagle Ford, what is happening in Colorado. So it expanded very quickly. At these prices, you can experiment. You can try.

After all, I think over 80 percent of oil wells drilled in the world every year are drilled in the United States. So this is where you experiment and where this experimentation goes. So the question right now is how much the experimentation made in the United States can branch out and go and have impact on other resources that we know exist, but we couldn't get out because prices were too high. We didn't have the technology, et cetera. How much we can replicate the example of the United States in terms of technology and success.

That is really the big question, both for gas and for oil.

Senator HOEVEN. I think it is interesting the way you describe it and, right, breaking the code in terms of producing these different types of energy because it also, over time, brings the price down. So other thoughts on what we can do to continue that kind of entrepreneurial development here?

Obviously, price is one. But the regulatory environment? What else? I mean, are there other things companies are specifically looking for or that you are seeing having a real impact on production around the world?

Mr. NEWELL. I will just expand a little bit on what was said. We are currently at EIA going beyond the domestic assessment of shale gas and broadening that internationally to assess the potential for shale gas development globally.

We are working on that. That, depending upon what we find there, would tend to enter into our international energy outlook, which we also produce each year. Some of the main prospects there that we already see certainly include Canada. It clearly has shale gas basins, which, in effect, extend upward from ours across the border.

Also, China and some parts of Eastern Europe seem to be promising places. But my sense is this has been very much driven by market response to high prices that existed at one point, which then encouraged the application of certain technology, and then there was innovation in that technology.

The CHAIRMAN. Any other final comment on this?

Mr. JONES. I was going to ask the Senator, you only focused on oil and gas. Are you talking about technologies in general? Because there are a lot of examples of innovative policies, for example, that are being deployed in Europe and elsewhere on renewable energy.

Senator HOEVEN. I really was interested in other energy sectors as well, including renewables. But I do see that I am past my time. So out of deference, Mr. Chairman, I will relinquish back.

The CHAIRMAN. Did you want to make a short response—

Mr. JONES. Yes. Just shortly, I mean, there are a lot of things like feed-in tariffs, for example, or portfolio standards that are used in various places. But the key thing seems to us to be clear, consistent policies that are as technology neutral as possible, but that also take into account the development stage of the technology.

A lot of technologies need a hand up, so to speak, to get across what is called the "valley of death" between the R&D of the development of the technology and the full commercialization of it because you have got to get economies of scale. So, those are areas where some countries have demonstrated how to get across that

valley by supporting companies at a key stage of the development of their technologies.

Senator HOEVEN. Mr. Chairman? So, if you had some of those examples, I would love to get them from you. Any that you think have been particularly effective in stimulating production.

Thank you, Mr. Chairman.

The CHAIRMAN. All right.

Senator Franken.

Senator FRANKEN. Thank you, Mr. Chairman.

Senator Manchin asked why there weren't subsidies for coal, and none of you seemed to want to answer that. I don't know if it was a rhetorical question, but it seems that coal is doing pretty well without subsidies. It is very plentiful. It is very cheap, relatively, and relatively, compared to other fuels, kind of dirty and, therefore, we don't subsidize it.

But speaking of subsidies, President Obama has called for kind of a suite of cuts in subsidies and tax preferences for oil companies. What effect, Dr. Newell, do you think that such a cut would have on domestic oil production or gasoline prices?

Mr. NEWELL. We haven't specifically evaluated the Administration proposals for changes in those tax incentives.

Senator FRANKEN. OK. Fair enough.

In a 2009 statement to the Senate Finance Committee—and I have this is right here—Alan Krueger, Assistant Secretary for Economic Policy and chief economist at the Treasury Department, said, and I quote, “Because we expect little or no effect on the world supply of oil, removing these subsidies would have an insignificant effect on world oil prices.”

He goes on to say that the decrease in domestic production due to these cuts would be less than 0.5 percent. Even in the long run—this might sound rhetorical, but anyone wants to pick up on it—doesn't this sound like an industry that doesn't need tax benefits and subsidies to survive? Anybody?

Mr. BURKHARD. One thing to keep in mind as you discuss the future of the fiscal terms that govern oil and gas companies—and again, I am not an expert on subsidies. So, but one aspect to keep in mind is American oil and gas companies are competing in a very competitive global marketplace. How they are taxed here or at home can affect how they can compete against companies from Asia, Europe, or other places.

So I don't have a specific answer, but I think having that global—

Senator FRANKEN. The largest 5 oil companies in the last decade have made over \$1 trillion in profits. 2010 profits were double that of 2009. Now we have seen ads from these companies talking about how much they are doing to invest in alternative energy production. You see it all the time. They are feel-good ads, I think.

I remember I felt great about BP because it had the little green thing. It was beyond petroleum. I think everyone in America thought like, “BP, that is the future. Boy, that is great.” I loved those ads. Then we learn that BP had like the worst safety record of any of these oil companies.

So these ads, I am wondering how much really are these companies doing, investing in alternative energy? I mean, Mr. Diwan, you

said that oil and gas companies are in the business of oil and gas. Isn't this really what they are doing negligible?

Mr. DIWAN. They are oil and gas companies. I repeat that. There is a scale issue. These are huge companies. I mean, Exxon is the largest company in the world. Chevron is \$200 billion capitalization. The renewables business is very small.

So even if they are doing a lot, it would not be material for the companies.

Senator FRANKEN. But it would be material for the world of renewables?

Mr. DIWAN. Correct. But they are companies. I mean, they have a mission, and that is what they are doing.

The scale issue is that you wouldn't expect these large companies to be the key innovator, investor, et cetera. I mean just from an economic perspective. So we can't ask them to be what they are not. They might pretend to be something that they are not, but that is a different issue.

Senator FRANKEN. OK. So you can't ask them to be what they pretend?

Mr. DIWAN. Yes.

Senator FRANKEN. OK. I will write that one down.

But going back, Mr. Burkhard, to my question, you were saying that they have to compete on a world basis. They are doing unbelievably well, right?

Mr. BURKHARD. They—

Senator FRANKEN. That is a relative term, "unbelievably." But they are doing very well. I mean, if Exxon makes \$9 billion this quarter, that is—do they really need these subsidies? Do they really need these tax preferences?

Mr. BURKHARD. I mentioned earlier that oil companies are price takers and not price makers. There, the level of their revenue, which is large, the level of their capital expenditures is large. When prices are high, that we see what the results are. So they are a reflection of what has been happening in the global oil market.

Last year, we saw Chinese oil demand grow 10 percent, 10 percent in 1 year from China.

Senator FRANKEN. So I think your answer to my question is, no, they don't really need these subsidies. So that is what it sounds like. That is my interpretation. You don't have to nod or agree. But for the record, he wasn't nodding.

[Laughter.]

Senator FRANKEN. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Coons.

Senator COONS. Thank you, Mr. Chairman.

I would like to follow up on the colloquy with both Senator Hoeven and Senator Franken. Ambassador Jones, you were talking about, I believe, the valley of death and other nice ways to describe the challenges of early stage commercialization and scale-up of innovations.

To the exchange you just had with Senator Franken, Mr. Burkhard, there is a real question in my mind about the appropriate role of the Federal Government in either subsidizing ongoing oil and gas exploration and development or alternative energy tech-

nologies. The projections that are made in the World Energy Outlook for the makeup of the total sort of global energy picture in 2035 is a bracing reminder that this is largely a petroleum-based economy and will remain so for much of the next few decades.

You mentioned in the conversation with Senator Hoeven, he asked for some insights about how we could be more effective, what other countries are doing. I would welcome input from any member of the four who are in front of us, the panel, how we are most likely to be successful in securing capital investment and job growth in the United States as renewable energy technologies scale up.

Given the numbers you gave, it seems to me as if wind and hydropower have the largest potential, and solar comes next. Admittedly, they are small in scale in the global economy. But there is a great deal of interest in them in most of our home States.

So, the question is if we have to choose between continuing essentially to expend Federal dollars in subsidizing oil and gas development, drilling, distribution or in providing subsidies that will encourage and accelerate the development of renewables, how can we have the best bang for the buck in terms of employment and deployment, the creation of jobs in the United States and the deployment of technologies that have positive long-term opportunities for us?

I also just wanted to clarify something. I assume, from some of these projections about the renewables sector, that most of the growth will come outside the United States, that the actual use of renewable source energies will be mostly in China and less in the United States. But I may have misread that in the materials I looked at before coming today.

So I would appreciate your wading through the complicated question. I would be happy to focus it if any of you want to take a particular piece of it.

Mr. NEWELL. I will just quickly respond to the last part of your question in terms of the magnitude of renewable energy deployed into the United States relative to the rest of the world. You are correct, but the U.S. is a small fraction of the entire world.

So, one would expect that—

Senator COONS. We tend to forget that.

Mr. NEWELL. Yes. So the other key factor there is that the U.S. need for energy is growing much more slowly than it is in other parts of the world. So, key factors are how big we are currently, and the growth is predominantly elsewhere in terms of energy consumption. So, that really does reorient both energy consumption as well as different types of energy supply. Growth is in other parts of the world.

Our assessment looking out over the next 25 years is that energy consumption by the OECD countries, of which the United States is one, is growing modestly-roughly flat whereas overall energy consumption globally will have perhaps 50 percent growth over the next 25 years. So, very significant global growth, most of it outside of OECD.

Senator COONS. I assume also some of it in countries that don't have an existing power distribution system or grid so that renewables may grow more rapidly in remote parts of the world where there is no existing infrastructure so that you are literally leap-

frogging the existing largely petroleum-based infrastructure in the United States.

Ambassador.

Mr. NEWELL. That has certainly been one of the interests in solar energy technology and other distributed energy generation, yes.

Mr. JONES. I just would like to add to Richard's comment that there is probably a lot of headroom still left for expansion in energy consumption overseas, especially in China. Because even with all the growth that they have seen, I think China's per capita energy consumption is like a third of the OECD average. So they can keep growing for a long, long time.

That is, I think, what is going to drive the development of energy consumption. The energy industry, technology, everything is going to be driven because you have got a huge mass of people there that have—basically, their growth has become self-sustaining. They are no longer dependent on imports, and their disposable income has risen dramatically, as we heard, and they have got a lot more development to undertake, and they are going to do it. It is going to change the world.

They are not alone. India is the same. Maybe not quite as far up the development scale as China, but they are also going through this. So that is why in the International Energy Agency, we are very concerned about the growth in the technologies they use. If they use coal, we really are going to have a tremendous increase in carbon dioxide in the atmosphere, for example.

It is not just carbon dioxide, it is other pollutants associated with coal. Those pollutants can cross the Pacific Ocean. So we are very concerned about how China and India satisfy their insatiable appetite for energy over the next 2 to 3 decades. It matters a lot for our welfare here.

Even though we are not consuming increasing amounts of energy, if they are, it is going to affect our environment. It is going to affect our prices and our economy.

The CHAIRMAN. Any other comment anyone wanted to make in answer to this?

Let me then see, Senator Murkowski, did you have additional questions?

Senator MURKOWSKI. No, Mr. Chairman.

The CHAIRMAN. Senator Coons, did you have additional questions?

Senator COONS. No, Mr. Chairman.

The CHAIRMAN. Thank you all very much. I think it has been a useful hearing, and we appreciate your expertise and your time today.

Thank you. That concludes our hearing.

[Whereupon, at 11:55 a.m., the hearing was adjourned.]

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

DEPARTMENT OF ENERGY,
ENERGY INFORMATION ADMINISTRATION,
Washington, DC, July 25, 2011.

Hon. JEFF BINGAMAN,
Chairman, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.

DEAR MR. CHAIRMAN: On July 22, 2011, you were provided answers to 47 questions submitted by Senator Sanders, Murkowski, and Cantwell following the February 3, 2011, testimony by Richard Newell before the United States Senate Committee on Energy and Natural Resources.

The Department of Energy provided answers to questions outside of the U.S. Energy Information Administration's purview. Specifically, Senator Murkowski's question number three (Liquid Fuel Imports) directed to Dr. Richard Newell and questions one (US Energy Companies Versus National Oil Companies), three (Major Oil Discoveries), four (Crisis-Drive Energy Policy), five (Clean Energy Standard), seven (Foreign Oil Dependence), 12 (Impact of Federal Policies), and 13 (Modular Nuclear Reactors) directed at all panelists. Senator Cantwell's question 4a (Effect of New Production Technologies on Prices), 8 (Implications of Business as Usual) and 11 (How to Increase Energy Diversity) asked of all witnesses.

Sincerely,

HOWARD K. GRUENSPECHT,
Acting Administrator.

RESPONSES TO QUESTIONS FROM SENATOR SANDERS

CLEAN ENERGY STANDARD

Question 1. The President has proposed a "clean energy standard" that would require 80 percent of our electricity to come from "clean" sources by 2035. Based on the Energy Information Administration's resources and data, if such a policy was established and it permitted natural gas, nuclear, and coal with carbon capture and sequestration to qualify either in whole or in part for credits toward the 80 percent goal, what impact, if any, would this standard have on renewable energy production from wind, solar, geothermal, and biomass?

What are your projections for solar in particular under such a standard; would we be likely to see any significant solar energy deployment under this standard? What percentage of "clean energy" in 2035 do you foresee, under the new standard, as coming from solar, both photovoltaic and concentrated solar.

If such a policy included a tier system, whereby at least one tier of the 80 percent requirement (perhaps 25 percent) was stipulated for renewable energy production, would that serve to increase projected renewable energy deployment under this standard?

Answer. The clean energy goal proposed by the President has not yet taken the form of a specific legislative proposal. Without the specific structure of a proposed policy, EIA cannot provide reliable estimates of its potential impacts.

In the past, however, EIA has analyzed several legislative proposals for renewable portfolio standards, renewable energy standards, clean energy standards, and similarly-structured policies to require minimum shares for specific generating resources. Through these analyses, EIA has found that numerous policy details can significantly influence the impact of the policy on key indicators such as the generation mix, cost to consumers, cost to industry, and even achievement of the targeted generation share. These key parameters include the existence and level of any limits on the price of renewable/clean energy credits; exemptions for certain classes of util-

ities or exclusion of certain generation from requirements of the program; the ability to “bank” early compliance credits; and the existence of “credit multipliers,” “set-aside” targets, and tiered compliance systems that incentivize specific technologies within the suite of eligible technologies. However, since the broad outline of the President’s proposed goal is different from the proposals previously analyzed by EIA, one should be cautious in relying on earlier analyses for guidance on the new goal. When this goal is more completely specified as a policy proposal, EIA will be in a better position to evaluate its potential impacts.

OIL AND EFFICIENCY

Question 2. As you know, the current greenhouse gas and fuel economy standards will take us to roughly 35.5 miles per gallon for cars and light trucks by 2016, and the Administration has announced plans to develop new standards through 2025. What would the impact be on oil consumption and greenhouse gas emissions in the United States if the Administration announced a new standard of 60 miles per gallon by 2025, as has been encouraged by a bi-partisan group of Governors and a number of retired senior military officers, and which is still somewhat less ambitious than the announced standards for fuel economy in Europe? How many barrels of oil would we save compared to business as usual?

Answer. EIA has not performed a specific analysis of increasing light-duty vehicle fuel economy to 60 miles per gallon by 2025. Our forthcoming Annual Energy Outlook 2011 (AE02011), to be released this spring, will include alternative scenarios of increased light-duty vehicle fuel efficiency.

SOLAR

Question 3a. Does EIA have a projection for when residential and commercial solar photovoltaic energy will reach grid parity in cost for a significant segment of electric customers in the United States (such as 20 percent or 50 percent of electric customers)?

Answer. EIA does not have a projection for when the price of residential and commercial solar photovoltaic energy will be at or below the retail price of electricity from the grid for a significant number of electric customers. The cost of electricity from the grid varies significantly across the Nation. Also, grid electricity and electricity produced by on-site photovoltaic systems are not identical products, since the former is generally available to follow load requirements while the latter follows the availability of the intermittent solar resource.

In EIA’s Annual Energy Outlook 2011 Reference case, near-term average growth in residential and commercial solar photovoltaic generation is 26 percent per year from 2010 through 2016 while the 30-percent Federal investment tax credit is available. From 2017 through 2035, after the Federal tax credit for residential systems expires as currently scheduled and the business investment tax credit returns to its permanent 10-percent level, average annual growth in residential and commercial solar generation slows to 1 percent per year, even as technology costs are projected to decline. The rate of adoption after 2016 indicates that purchasing electricity from the grid is projected to remain the economic choice for most residential and commercial customers in the United States through 2035.

Question 3b. How would it impact EIA’s projections for solar energy deployment, as compared to business as usual, if solar energy reached parity with the price of electricity from the grid in 50 percent of the United States by 2013?

Answer. EIA has not analyzed a scenario with the price of solar energy at or below the price of electricity from the grid in 50 percent of the United States by 2013 and cannot provide estimates of the potential impacts of this specific scenario. EIA’s Annual Energy Outlook 2011 (AE02011) Reference case provides an illustrative example of the impacts that solar costs can have on projected deployment. In the Reference case, electricity prices to residential and commercial consumers are expected to remain stable through 2035 in real terms. Near-term average growth in residential and commercial solar photovoltaic generation is 26 percent per year from 2010 through 2016 while the 30 percent Federal investment tax credit is available, as is currently scheduled. From 2017 through 2035, after the Federal tax credit for residential systems expires and the business investment tax credit returns to its permanent 10-percent level, average annual growth in residential and commercial solar generation slows to 1 percent per year, even as technology costs are projected to decline. The full release of the AE02011 will contain a number of additional cases that assume lower technology costs or extended incentive policies for solar energy. These cases can be used to better understand the potential deployment of these technologies under more favorable conditions than may be found in the Reference case.

GREEN JOBS

Question 4. Do you have data on solar photovoltaic energy and wind energy utilized in this country that includes breakdowns for country of manufacture of solar panels and wind turbines by year, and job creation related to solar and wind manufacturing, installation, and maintenance in the United States? If you do not have this type of data, can you inform the committee whether you could supply such data and whether you plan to, similar to your efforts in documenting manufacturing of geothermal heat pumps?

Answer. EIA collects some data on the import of solar PV generating equipment to the United States if it passes through a U.S. manufacturer. In 2009, U.S. PV manufacturing companies reported shipments of 987 MW of solar photovoltaic equipment, including cells and modules, and 587 MW of imported solar photovoltaic equipment. During that year, U.S. solar PV manufacturers also reported solar photovoltaic exports of 462 MW. While EIA does not collect import or manufacturing data for the wind industry, a report released by Lawrence Berkeley National Laboratory in August of 2010 indicates that in 2009 the U.S. imported 39 percent of wind turbine equipment on an equipment-cost basis.

Although EIA collects import and export data on shipments of photovoltaic equipment from U.S. manufacturers, and while this data can be useful in illuminating gross trends in equipment sourcing for this market, this data can only provide limited insight into the actual point-of-origin composition of the installed photovoltaic capacity market. In the current market, component manufacturing activities may occur in different locations for the same finished, installed module. Even core components like the photovoltaic cells can pass through several locations, perhaps with initial cell casting in the United States, shipment to a foreign facility for assembly into a finished module, and re-shipment to the United States for integration with other components into a final installed system. EIA does not track the movements of specific shipments, and thus cannot disaggregate the specific path-of-travel of any given module. Neither does EIA track photovoltaic modules to the final point-of-installation, and thus cannot provide installed module locations or other statistics on installed capacity for most photovoltaic modules. Finally, EIA does not track shipments that do not have a domestic manufacturing component, and may miss modules that are entirely manufactured overseas and shipped to U.S. installers without passing through a U.S. manufacturer along with way.

Although the researchers at Lawrence Berkeley National Laboratory have access to different data sources for their estimate of wind equipment imports, they also report problems with accounting for cross-national, multi-stage manufacture of this complex product.

EIA survey respondents report over 14,000 jobs in 2009 in photovoltaic manufacturing. EIA does not have sufficient data on wind or solar distribution and installation industries to estimate industry employment. Employment estimates for specific industries are usually provided by the U.S. Bureau of Labor Statistics, which collects primary labor survey data and is better equipped than EIA to provide industry-specific estimates of U.S. employment trends for other manufacturing, distribution, and installation activities.

RESPONSES TO QUESTIONS FROM SENATOR MURKOWSKI

CELLULOSIC FUELS

Question 1. It appears that your agency has forecast continued—and significant—shortfalls in cellulosic biofuels production. Can you explain where cellulosic technology is today, why it has been so slow to take off, and how far below our targets we may be in 2022? What will it mean for the Renewable Fuel Standard if we continue to fall so acutely short of its annual production mandates?

Answer. A review of the industry reveals several significant factors that have contributed to the delay in available advanced biofuels production. Studies show that capital costs have risen significantly above the original expectations for these technologies. In addition, biomass feedstock costs have also been substantially higher than originally expected and process yields have not achieved goals. At least 6 planned facilities have delayed startup by 6 months or longer, while only 3 plants have reached the startup phase—with many more awaiting financing. Many in the industry face important financial, legal, and technological issues that have yet to be resolved.

A direct consequence of the slow market penetration of the technology is the requirement that EPA make available for sale cellulosic biofuel credits at costs significantly below the current production cost for the cellulosic biofuels. If this were to continue, EPA would need to evaluate whether to utilize the discretion authorized

by Paragraph (7) of section 211(o) of the Clean Air Act to also reduce the advanced and total schedules which would ultimately delay the timetable for attainment of the total volume target for renewable motor fuels under the Renewable Fuel Standard.

EPA REGULATIONS

Question 2. Understanding that proposed legislation and regulations are not incorporated into the agency's forecasts. [sic] Now that the EPA's climate regulations have begun to go into effect, will those be included in your agency's work? Is it possible for EIA to model those regulations? Can you tell us anything about what you expect their costs to be, on energy prices or for our economy as a whole?

Answer. While EPA is developing regulations pertaining to greenhouse gas (GHG) emissions from power plants and other large sources, together with the states, it has not released specific standards for different plant types. Without such standards, EIA cannot effectively model any impacts of EPA's proposed regulations. EIA is monitoring EPA's progress in developing the rules, and when more information on the specific standards is available, we will adjust our analysis accordingly.

EIA does try to capture current market behavior with respect to concerns about GHG emissions and their potential regulation in its modeling. In order to account for the uncertainty surrounding investment decisions in GHG-intensive technology, and to reflect current market behavior, EIA assumes a 3 percent increase in the cost of capital for new coal-fired power plants and other GHG intensive technologies, which is one of the reasons that relatively few new coal-fired power plants beyond those already under construction are added in the AE02011 Reference case projections. In addition, 10 states in the Northeast are required to meet the requirements set by the Regional Greenhouse Gas Initiative (RGGI) and this is represented in the EIA analyses.

LIQUID FUELS IMPORTS

Question 3. Your agency has forecasted that liquid fuels imports will decrease by just a fractional amount over the next 25 years, from 9.7 million barrels a day last year to 9.4 million barrels a day in 2035. Assuming that accounts for higher fuel economy standards and the emergence of advanced vehicles and biofuels. Can you describe any other actions we might take, such as increasing domestic oil production, that would cut our foreign oil dependence?

Answer. The EIA projections you refer to represent a "business as usual" forecast that includes existing policies but not new initiatives. In March, the President laid out a bold goal of cutting goal imports by one-third by the year 2025, relative to 2008. To achieve that goal, the Administration is committed to expanding the safe and responsible production of domestic oil and natural gas; improving the efficiency of our vehicles; and promoting innovation in new technologies like advanced biofuels and electric vehicles.

US ENERGY COMPANIES VERSUS NATIONAL OIL COMPANIES (NOCS)

Question 1. Can you describe how U.S. oil and gas producers operate with any disadvantages relative to National Oil Companies such as the OPEC owner companies?

Answer. National oil companies (NOCs) now control over three-quarters of the world's oil reserves. The OPEC NOCs have the obvious advantage that the bulk of conventional oil resources are located in their home countries and they usually have exclusive access to these oil reserves. About 40 percent of the world's current production comes from OPEC and this oil is relatively inexpensive to produce. How OPEC manages its supply has an important impact on world markets. OPEC is capable of expanding their low-cost production and OPEC has historically played a role in adjusting supplies of oil in response to growing demand.

OIL MARKETS

Question 2. If only about 3 percent of the world's oil travels through the Suez Canal and the SUMED pipeline, yet we are seeing some influence on the global commodity price resulting from the instability around the Suez, does this indicate seemingly small disruptions, real or potential, can have comparatively large impacts on global markets?

Answer. The market impact of such a supply disruption can go beyond volumetric loss. Although Egypt is not a large exporting country, it is important to the oil markets for several reasons: as a transit corridor, because of its very high profile in a broader region—the Middle East and North Africa—that is of critical importance to

energy markets, and because of the risk of unrest rippling through the rest of the region. Earlier this year, as unrest mounted in Egypt, the market grew concerned that oil traffic through the Suez Canal and the Sumed (Suez-Mediterranean) pipeline might be halted. The market also became increasingly concerned about the risk that unrest and potential disruptions could spread—as eventually happened in Libya. Also, even though the disruption occurred against a context of relatively comfortable spare oil production capacity, and total Organization for Economic Cooperation and Development (OECD) oil inventory levels are generally comfortable by historical standards, the latter were not evenly distributed throughout the world and were markedly tighter in Europe, the primary market for Libyan crude, than in North America. The European Brent crude oil market had been tightening before the start of unrest.

At the same time, there is not enough surplus capacity to offset an unlikely scenario where the oil supplies would be halted in the countries in the Middle East and North Africa where political protests have taken place. These countries produce a combined 30.4 million barrels per day of petroleum liquids, or 35 percent of the world's total supply. In addition, these countries have virtually all of the world's spare production capacity. Because of the large amount of global oil supplies produced in these areas, markets have been concerned that political protests in the Middle East and North Africa could potentially have large effects on world oil markets.

MAJOR OIL DISCOVERIES

Question 3. What was the impact on global investment and markets when the Tupi field was discovered off Brazil in 2006, and how does the addition of a multibillion barrel discovery impact the host nation and the industry?

Answer. The first discoveries in the pre-salt area offshore Brazil were located in the Tupi field in the Santos Basin in late 2006. Petrobras (Brazil's state-owned oil company) confirmed that the Tupi field alone holds 5-8 billion barrels of light grade crude oil and is at a depth of three miles below the surface of the ocean. With an estimated potential of 50-80 billion barrels of oil equivalent in the pre-salt area (due to its geologic location under a cap of salt), Brazil's oil production potential represents one of the most significant finds in the industry over the last three decades. President Dilma Rousseff is deeply involved in setting Brazil's policies on oil production.

Impact on global investment and markets

Brazil is producing approximately 100,000 barrels per day this year in the pre-salt area. Production could reach 1 million barrels per day by the middle of this decade. Brazil's oil production has risen steadily in recent years, and the country has recently become a net oil exporter. The new pre-salt discoveries are world class and some analysts believe Brazil has the potential to become a significant exporting country. However, considerable challenges must still be overcome in order to bring these reserves to market. The difficulty of accessing reserves, considering the large depths and pressures involved with the pre-salt oil production, represent significant technical hurdles that must be overcome. Further, the scale of the proposed expansion in production will also stretch Petrobras' exploration and production resources and Brazil's infrastructure, as well as its financial capacity to meet investment demands.

Many countries, either through direct negotiation with the Brazilian government or through their respective National Oil Companies (NOC) or conglomerates, are aggressively seeking access to these new resources.

CRISIS-DRIVEN ENERGY POLICY

Question 4a. The Outer Continental Shelf Lands Act was implemented after the Arab oil embargo and subsequent price controls and economic shocks of the 1970's, as was the authorization of the Trans-Alaska Pipeline System. Are these patterns of crisis and response an unavoidable trend in U.S. energy policy?

Answer. The United States has naturally paid increased attention to energy policy after particular events such as the oil embargo of 1973 and other periods of sharply increased energy prices. Nonetheless, important energy initiatives have been enacted in more normal times due to continuing concerns on the part of the Congress, the Administration, the States, U.S. industry, and the public. Examples of important policy initiatives that have been enacted without any shocks to the energy supply system include the Energy Policy Act of 2005 and the American Recovery and Reinvestment Act of 2009 (ARRA). ARRA included more than \$80 billion for increasing generation from renewable energy sources; expanding manufacturing capacity

for clean energy technology; advancing vehicle and fuel technologies; and building a bigger, better, smarter electric grid, all while creating new, sustainable jobs. Other examples are described in the following answer.

Question 4b. Is the U.S., in your group's view, more proactive or reactive in its energy policy?

Answer. While an answer necessarily has a subjective element, there are reasons to believe that the United States has become more proactive in its energy policy compared to past years. For example, there have been other reasons besides high energy prices to develop advanced energy technologies. Concerns over climate change have motivated clean energy policies even when energy prices have been low. Often, environmental and energy security concerns line up to redouble our energy policy efforts. We achieve both objectives, for instance, when we improve energy efficiency. New requirements for higher motor-vehicle efficiency and low-emission biofuels are moving the transportation sector away from oil dependence while also reducing greenhouse gas emissions.

CLEAN ENERGY STANDARD

Question 5. Should we learn a lesson from the Renewable Fuel Standard, which has fallen short of expectations, when considering an aggressive electricity mandate like the one the President is calling for? How likely is it that we will create unforeseen problems if we put a CES in place? To name just one example, will transmission problems—and our inability to add significant amounts of renewable energy to the grid—become the new “blend wall”?

Answer. The President's Clean Energy Standard is designed to achieve the deployment of clean energy technologies as cost-effectively as possible. Rather than picking winners and losers among technologies, the CES would include a very broad range of energy sources, including renewable (like wind, solar, hydro, and geothermal) as well as nuclear, efficient natural gas, and clear coal. To address your specific question on the issue of transmission needs under a CES, the amount of new transmission that would be needed relative to the transmission needed under “business as usual” is difficult to predict, given that the CES does not choose among clean technologies. To the extent that expanding renewable energy generation creates needs for new transmission infrastructure, the Administration is working hard to address those needs. For example, the President's FY 2012 budget proposal includes two new Energy Innovation Hubs, one devoted to Smart Grid Technologies and Systems and another to Energy Storage, technologies that can ease the integration of variable renewables into the electric grid. This is in addition to the research and development work in these areas already funded by the Department of Energy in its Office of Science, Office of Electricity Delivery and Energy Reliability, and Office of Energy Efficiency and Renewable Energy. Moreover, the Administration recently announced the creation of a Renewable Energy Rapid Response team to address barriers to the permitting and siting of renewable projects, including transmission lines.

ALTERNATIVES TO OIL

Question 6. How substantial of an impact do you believe advanced biofuels, electric vehicles, and other technologies will have on petroleum consumption by 2020? By 2030?

Answer. The Annual Energy Outlook 2011 Reference case projects that advanced biofuels will displace 300,000 barrels per day of crude consumption by 2020 (3 percent of projected refinery crude inputs) and 830,000 barrels per day by 2030 (6 percent of projected refinery crude inputs). Although sales of plug-in electric vehicles, which includes battery electric vehicles and plug-in hybrid electric vehicles, increase over the projection period and reach 2 percent of new light vehicle sales by 2030, they account for less than 1.5 percent of all light-duty vehicles in use by that time and have only a modest impact on light-duty vehicle petroleum demand. Hybrid vehicles, diesel vehicles, and other advanced conventional vehicle technologies (e.g., turbo charging and light weight materials) are projected to make more significant contributions to fuel economy improvement in the Reference case projection. The cumulative effect of increased use of biofuels, advanced biofuels, and fuel economy improvements results in a slight decline in light-duty vehicle petroleum demand from current levels over the Reference-case projection period, despite the significant increase in the number of vehicles and vehicle miles of travel.

FOREIGN OIL DEPENDENCE

Question 7. If Congress had allowed the Coastal Plain of ANWR and other parts of Alaska to be opened to production, in 1995 for example, we would be producing

domestic oil at a considerably higher rate. What would that mean for our nation's energy security? Would we be more protected, or less protected, from civil unrest in Egypt, Jordan, and other parts of the Middle East? In the event of a supply disruption abroad, would we be better equipped, or less prepared, to deal with import shortages?

Answer. The amount of oil produced would depend on a number of economic, geologic and technical factors, with production not occurring until about ten years after the beginning of exploration. The most recent USGS evaluation of potential oil reserves from the area occurred in 1998. USGS estimated a 95 percent probability that at least 5.7 billion barrels of technically recoverable undiscovered oil are in the ANWR coastal plain and a 5 percent probability of at least 16 billion barrels. The mean estimate was 10.3 billion barrels.

Based on these estimates, EIA has conducted several analyses of the potential annual production from this area. In its most recent analysis in 2008, EIA concluded that the opening of the ANWR 1002 Area to oil and natural gas development was projected to increase domestic crude oil production starting in 2018 (assuming exploration started in 2008). In the mean resource case, production peaks at 780,000 barrels per day (bpd) in 2027 and declines to 710,000 bpd by 2030.

According to the EIA's 2008 analysis, additional oil production resulting from the opening of ANWR would be a small portion of total world oil production. Based on the most recent estimates of U.S. production and imports from the EIA Annual Energy Outlook 2011, ANWR production of approximately 750,000 bpd could potentially displace between 8 and 9 percent of U.S. oil imports annually or about 1 percent of world production. The impact on world oil prices—and therefore U.S. crude oil and gasoline prices—would be correspondingly small; in the mean resource case, EIA estimated a reduction in low sulfur, light crude oil prices of \$0.75/barrel (translating into less than 2 cents per gallon of gasoline). As a result the opening of ANWR would have little effect on U.S. energy security in terms of our vulnerability to high world oil prices.

Because oil is priced in a global market, however, the opening of ANWR would have little effect on the consequences of political unrest or a supply disruption in the Middle East. The main impact of these events would likely be higher oil prices worldwide, which would adversely impact the economies of all oil-consuming nations, including the United States. That is why the President is committed to reducing our nation's overall consumption of oil, for example through increased vehicle efficiency, at the same time that it is taking steps to promote safe and responsible oil and gas development and alternative fuels.

PROJECTED OIL PRICES

Question 8. In a hypothetical scenario of September 2012, with unemployment down to 8%, the economy growing at greater than 3% each quarter, and world markets on the upswing, where would you forecast the price of oil?

Answer. In EIA's March's Short-Term Energy Outlook, U.S. gross domestic product (GDP) growth for 2011 and 2012 was 3.2 percent and 2.8 percent, respectively, with the unemployment rate averaging 9.0 and 8.5 for 2011 and 2012, respectively. EIA projects U.S. liquid fuel consumption to increase by an average 130,000 barrels per day in 2011 and a further 190,000 barrels per day in 2012, while world consumption grows by roughly 1.6 million barrels per day in each year. The price of West Texas Intermediate crude oil is projected to be \$102 in 2011 and \$105 in 2012.

With the somewhat higher domestic economic growth and lower unemployment rate posited by your question, a modest further increase in U.S. liquid fuels consumption would be expected but the effect on oil prices would be small given that the consumption increment is a very small fraction of projected world oil demand.

OFFSHORE MORATORIUM

Question 9. How does the amount of oil that could be taken offline by unrest in the Middle East compare to the amount of production that will be lost because of the absence of new exploratory permits in the Gulf of Mexico, and the absence of resumed exploratory operations?

Answer. The impacts on Gulf of Mexico (GOM) production associated with the stoppage, now ended, of deepwater development and exploration drilling in the aftermath of the April 2010 Macondo well blowout involve significantly lower volumes than the losses of production from the Middle East and North Africa that are the current focus of oil market attention. For example, roughly 1.5 million barrels per day of crude oil supply has been shut down since March 2011 due to the conflict in Libya. EIA's July 2011 Short-term Energy Outlook (STEO) assumes that only half of this production will be restored by the end of 2012. Because of the large

amount of global oil supplies produced in the Middle East and North Africa (about 30.4 million barrels per day), markets continue to be concerned that political protests in these regions could potentially lead to further disruptions that could have large effects on world oil markets.

In contrast, oil production in the Federal GOM is forecast to be close to its 2009 level in 2010 once final information from the Bureau of Ocean Energy Management is incorporated in EIA's data. While EIA's expects Federal GOM production to decline in both 2011 and 2012, the change from the 2009 level, at 0.07 million barrels per day in 2011 and 0.17 million barrels per day in 2012, is much smaller than the Libyan outage, and not all of this change can be directly attributed to the stoppage, now ended, in deepwater drilling following the Macondo well blowout.

ECONOMIC RECOVERY

Question 10. Adam Sieminski, the Chief Energy Economist for Deutsche Bank, recently wrote that "We estimate that a 10 dollar rise in the oil price subtracts approximately 0.5 percentage points off U.S. growth." Do any of you agree with Mr. Sieminski's assessment? Would this calculation change if the US supplied 60% of its own oil as opposed to importing 60% of its oil?

Answer. Some caution should be used when attempting to estimate the response of the U.S. economy to an oil price change. The magnitude of macroeconomic impacts depends on the magnitude of the price shock, its persistence, and the relative importance of oil to the economy. A major challenge to estimating the magnitude of oil price shocks on the economy is that some historically large oil price increases have been accompanied by other macroeconomic factors and policies that have also impacted aggregate demand. That said, EIA's analysis suggests a lower impact of oil price increases on the U.S. economy, implying a rough rule of thumb that each \$10 per-barrel increase in the price of oil lasting for one year would reduce gross domestic product by about 0.2 percent in that year, as well as in the following year.

The magnitude of the impacts on the U.S. economy depends upon how long the oil price increase lasts, whether the change in the oil price is gradual, the oil price level when the price change occurs, and the availability of substitutes to oil. Economic impacts vary depending on whether the oil price change results from supply constraints or from increased demand due to robust economic and income growth. The impact on the economy also depends on pre-existing economic conditions including the rate of inflation, interest rates, and monetary policy.

These results would change if the U.S. were not a net oil importer. Since the United States imports a large percentage of its oil, the terms of trade (the volume of exports needed to purchase a given volume of imports) deteriorate when the price of oil increases because U.S. consumers pay more for the same amount of oil and are therefore less able to purchase other goods.

PRICE INCREASES

Question 11. The head of the Bipartisan Policy Center noted earlier this week that "A one-dollar, one-day increase in a barrel of oil takes \$12 million out of the U.S. economy. If tensions in the Mideast cause oil prices to rise by \$5 for even just three months, over 5 billion dollars will leave the U.S. economy." Do any of you disagree with that assessment?

Answer. In 2010, U.S. net crude oil imports averaged around 9.2 million barrels per day and net petroleum product imports averaged 0.4 million barrels per day, for a total of 9.6 million barrels per day. Assuming the average level of imports did not change in response to the price increase or other factors, a one-dollar increase in the price of oil would cost about \$9.6 million dollars per day in increased import costs. Again, holding constant the volume of imports, a \$5-per-day increase would amount to an increase of about \$48 million per day and result in a cumulative \$4.4 billion in increased import costs over a three-month period.

IMPACT OF FEDERAL POLICIES

Question 12. What role does the federal government's stimulus policies, and the Federal Reserve's second round of quantitative easing, have played in boosting commodity prices? Have these policies boosted the price of oil, and, if so, by how much?

Answer. The price of oil and other commodities is determined by many factors related to current economic and market conditions, as well as expectations about future conditions. Some major factors affecting current oil prices are expectations about the global economic recovery, the growth rate of Asian demand, and whether OPEC producers will be willing or able to meet demand growth without increased supply from non-OPEC producers.

The American Recovery and Reinvestment Act of 2009 (ARRA), the cornerstone of the federal government's stimulus policies, includes measures that provide both upward and downward pressure on oil prices. Two overall aims of ARRA are to create new jobs and save existing ones, as well as to spur economic activity and invest in long-term growth. Historically, increased economic activity has been linked to oil demand. Promoting economic growth provides upward pressure to current prices through expectations of higher future oil demand.

Measures funded by ARRA provide downward pressure on oil prices by reducing U.S. consumption of oil. The Department of Energy (DOE) is investing in energy-efficient and advanced vehicle technologies (hybrids, electric vehicles, plug-in electric hybrids, hydraulic hybrids, and compressed natural gas vehicles) that will reduce petroleum consumption by displacing conventional gasoline-and diesel-powered vehicles. DOE is also investing ARRA funds to support increased production and use of biofuels to directly displace petroleum products.¹

According to the Federal Reserve's Statement Regarding Purchases of Treasury Securities, the second round of quantitative easing aims to "promote a stronger pace of economic recovery and to help ensure that inflation, over time, is at levels consistent with its mandate."² As noted earlier, expectations of improved economic recovery provide upward price pressure on oil prices as economic activity is commonly linked directly to oil consumption.

MODULAR NUCLEAR REACTORS

Question 13. What role do you believe small modular nuclear reactors will have in meeting the global demand for electricity? What countries are moving forward with this technology and what countries are interesting in acquiring these reactors?

Answer. Small Modular Reactors (SMRs) could play a significant role in meeting the global demand for electricity. Many countries desire to pursue or expand nuclear energy programs and would see value in pursuing SMRs because of their potential benefits, such as lower capital costs, greater flexibility in siting due to lesser cooling requirements, ability to support smaller electrical grids, capability to replace fossil plants that have existing electrical infrastructure, and the lower risks of construction delays. Argentina, Japan, Korea, Russia, and the United States are moving forward in the development of SMR technology. Based on statements by representatives at international forums such as IAEA interactions, the following countries also have indicated interest in SMRS: Bangladesh, China, Estonia, Ghana, Indonesia, Jordan, Kazakhstan, Kenya, Malaysia, Mongolia, Morocco, Namibia, Nigeria, Russia, Senegal, Singapore, Sri Lanka, Switzerland, and Venezuela.

OIL SPILL REPORT

Question 14. Have you reviewed the recommendations made by the Presidents' Oil Spill Commission? Have you conducted any analysis on the impact those recommendations, if fully implemented, would have on domestic oil production, our import levels, and the global price of oil?

Answer. EIA's Annual Energy Outlook 2011 Reference case includes only current laws and regulations and thus our projections do not include recommendations of the President's Oil Spill Commission.

CHINA

Question 15. Can you shed light on what China's energy picture really looks like, not just for renewable energy, but also its future demand for oil, natural gas, and coal?

Answer. In the long-term, EIA projects all forms of energy will grow substantially to meet China's future demand. Between 2007 and 2035, China's renewable energy consumption alone more than quadruples according to the International Energy Outlook 2010 (IEO2010), EIA's latest assessment of world energy markets. China remains among the world's fastest growing regional markets for wind power expansion, with its total net wind-powered generation projected to increase from 6 billion kilowatt-hours in 2007 to 374 billion kilowatt-hours in 2035. Nonetheless, hydroelectricity remains China's largest source of renewable energy and, even in 2035, wind generation is only 30 percent the size of hydroelectric generation.

¹Department of Energy—Recovery and Reinvestment webpage, at <http://www.energy.gov/recovery/vehicles.htm>, accessed Feb 16, 2011.

²Federal Reserve of New York, Operating Policy: Statement Regarding Purchases of Treasury Securities, at http://www.newyorkfed.org/markets/opolicy/operating_policy_101103.html, accessed Feb 16, 2011.

Although China's is poised for a substantial rise in renewable energy use, fossil fuels will likely be used to meet much of the country's future long-term energy needs. Oil, natural gas, and coal still account for 86 percent of China's projected total energy use in 2035 in the 1E02010 Reference case, a decrease from its 2007 share of 93 percent. With its large domestic reserves, coal remains China's largest energy source throughout the projection, fueling both electric power and industrial sector requirements. Though the Chinese government intends to consolidate the coal sector by focusing on larger, more efficient mines, coal use grows at an annual average rate of 2.9 percent and roughly doubles by 2035 in the 1E02010 Reference case projection. Significant changes to existing law or technological breakthrough could, however, change this Reference case outlook.

Liquid fuels demand also increases rapidly, primarily to fuel China's growing transportation sector needs, rising in total consumption by 2.9 percent per year in the forecast period of the 1E02010. Natural gas, though a small contributor to China's fuel mix in absolute terms, is expected to be the fastest-growing fossil fuel during the forecast period, increasing 5 percent per year and doubling its share of the overall energy mix.

In the short term, China's oil consumption is projected to continue to grow during 2011 and 2012, with oil demand reaching almost 10.4 million barrels per day (bbl/d) in 2012. The anticipated growth of 1.2 million bbl/d between 2010 and 2012 represents about 38 percent of projected world oil demand growth during the 2-year period according to the March 2011 EIA Short-Term Energy Outlook.

EFFECT OF DOMESTIC DRILLING ON GAS PRICES AND FOREIGN OIL DEPENDENCE

Question 1a. In response to the recent political unrest in the Middle East, and rising oil prices, we have heard familiar calls to expand domestic drilling in the United States—including offshore and in the pristine Arctic National Wildlife Refuge (ANWR)—typically with the claim that such actions will lower gasoline prices or reduce our dangerous over-reliance on foreign oil.

An Energy Information Administration (EIA) study from May 2008 projected the effects on oil prices of drilling in the Arctic National Wildlife Refuge. According to EIA's projections, in the most optimistic case, drilling in ANWR would reduce crude oil prices by approximately \$1.44 per barrel. I understand this would translate to approximately 3 to 4 cents per gallon of gasoline at the pump about 20 years from now.

It seems that EIA has found that drilling offshore would have a similarly negligible effect on prices. EIA issued an analysis in 2009 that examined the impact of maintaining the historical moratorium on drilling off the Atlantic, Pacific, and Eastern Gulf of Mexico. According to that analysis: "With limited access to the lower 48 OCS...there [would be] a small increase in world oil prices... The average price of imported low-sulfur crude... is \$1.34 per barrel higher, and the average U.S. price of gasoline is 3 cents per gallon higher."

Mr. Newell, does EIA still stand by the findings in these recent reports?

Answer. EIA would not expect the overall findings in the aforementioned analyses of opening ANWR or maintaining the historical moratoria on drilling off the Atlantic and Pacific coasts and in the Eastern Gulf of Mexico (GOM) to change significantly if the analyses were to be updated. The results in both of these analyses reflect the significant amount of time that would be required for these sources to add to global oil supplies and the likelihood of offsetting demand and supply responses over an extended period.

Question 1b. Even if every acre of the United States were open to oil drilling both on and offshore would that lower gasoline prices today? Or in 2 years, 5 years, 10 years, or 20 years?

Answer. Although near-term production from areas that have already been leased can be highly sensitive to the pace of drilling activity, opening access to drilling on every acre of the United States not currently open to leasing would not necessarily have an impact on production and prices in the short-term. Before any drilling in such areas can begin, at a minimum, leases must be purchased, environment impact studies performed, and drilling permits submitted and approved. In the undeveloped areas of the offshore, the lead time between leasing and production is 5-10 years, depending on water depth and proximity to existing infrastructure. In the aggregate, by 2030 greater access to Federal lands and waters could increase crude oil production by about 1 million barrels per day (excluding oil shale) with ANWR accounting for most of the increase at about 700,000 to 800,000 barrels per day. The remaining volume is from the Gulf of Mexico. Regarding oil shale, the primary constraint to production is the rate of technological progress, particularly with respect to developing a commercially-viable in-situ production process. In the Annual En-

ergy Outlook 2011 Reference case, large-scale oil shale production is projected to begin in 2029 and reach 135,000 barrels per day in 2035, however, small-scale mining and retorting of oil shale on private lands could occur earlier.

Because oil prices are largely determined by the international market, the substantial lead time for new Federal leasing to result in new production allows for demand and supply responses over an extended period that can significantly offset the impacts of production from newly-leased areas. As a result, the longer-term impact of increased domestic oil production on gasoline prices is expected to be modest; a few cents per gallon in 2035.

Question 1c. EIA predicts that oil imports in 2035 will be about the same level as they are today. Is there any way that domestic drilling could significantly impact that level of dependency?

Answer. U.S. dependence on imported liquid fuels, which reached 60 percent in 2005 and 2006 before falling to 52 percent in 2009, is expected to continue to decline to 42 percent by 2035 as a result of increases in biofuels, natural gas liquids, domestic production from onshore enhanced oil recovery projects (primarily carbon dioxide flooding), shale oil plays, deepwater drilling in the Gulf of Mexico, and consumption increases that are moderated by fuel economy standards. More rapid technological improvements and wider application of existing technologies to emerging oil plays, as well as increased access to domestic oil resources in Alaska and the Outer Continental Shelf, could further reduce dependence on imported liquid fuels.

Question 1d. Would a permanent moratorium on drilling offshore the West Coast of the United States have any impact on future oil prices or the prices consumers pay at the gasoline pump?

Answer. A permanent moratorium on drilling offshore the West Coast of the United States is not expected to have a significant impact on gasoline prices. In addition to the more general points made in the response to question 1b, the Bureau of Ocean Energy Management, Regulation and Enforcement has indicated that there is low resource potential in that offshore region.

RESPONSES TO QUESTIONS FROM SENATOR CANTWELL

IS OPEC ABLE TO OFFSET ANY INCREASED DOMESTIC DRILLING

Question 2. A number of experts have argued that any price impact of increased domestic production can be easily offset by OPEC. According to another EIA fact-sheet:

One of the major factors on the supply side is OPEC, which can sometimes exert significant influence on prices by setting an upper production limit on its members, which produce about 40% of the world's crude oil. OPEC countries have essentially all of the world's spare oil production capacity, and possess about two-thirds of the world's estimated crude oil reserves.

Is it true that OPEC, by modestly curtailing its output, has the power to offset any downward pressure that a marginal increase in US oil production might otherwise produce?

Answer. EIA agrees that OPEC could modestly curtail crude oil production to offset increased U.S. oil production. This would eliminate the downward price pressure of increased U.S. oil production. However, it could also reduce OPEC revenue because of lower production by its members, which may affect some OPEC member countries' willingness to reduce production. It should also be recognized that, as was the case during 2007 and early 2008, OPEC spare capacity could fall to lower levels, reducing the ability of OPEC member countries to influence world oil prices by controlling production. Under such circumstances, OPEC countries may not want to curtail their production in response to higher U.S. production.

In the past, OPEC has demonstrated the ability and willingness to reduce production to limit price declines. In the fall of 2008, in response to rapidly falling world oil prices, OPEC reduced its target oil production from 29.7 million barrels per day (bbl/d) to 24.8 million bbl/d, or a targeted drop of 4.8 million bbl/d over a period of 3 months. Actual output from OPEC, including from Iraq, fell from 31.4 million bbl/d in October 2008 to 28.9 million bbl/d in February 2009, a reduction of 2.5 million bbl/d in less than 4 months. OPEC nations' government control of oil production levels, combined with their relatively low cost to develop and maintain production capacity, provides them with the ability to enact such significant supply reductions.

In contrast, during periods of significant non-OPEC supply expansion and ample OPEC spare capacity—such as during much of the 1990s—OPEC's pricing power has been much lower.

EFFECT OF SPECULATION ON OIL PRICES

Question 3a. Several of the [sic] testified that the oil price movements can be explained by supply and demand fundamentals and these explain the upward pressure we've seen in recent months. We often hear about the lack of a "conclusive" smoking gun that links oil price spikes to speculation in the derivatives markets.

However, as you may know, the recently-passed Dodd-Frank Act requires the Commodities Future Trading Commission (CFTC) to establish rules to eliminate excessive position limits. Unfortunately, 180-day deadline for those rules has passed and the regulatory process of establishing position limits is still in the early stages, and the limits are planned to be phased in over time.

Can the witnesses please comment on the likelihood of seeing a huge oil price spike this summer of the magnitude that we saw in the summer of 2008?

Answer. In July 2008, the WTI futures price rose to an all-time high, in both real and nominal terms. A review of information from both the financial and physical markets suggests the futures market is pricing in only a low chance of the July futures contract exceeding the \$145 price level seen in July 2008. As of March 25, the futures market for North Sea Brent crude oil is pricing in a 7 percent probability that the July contract will exceed price levels seen in 2008 and a 2 percent chance for the similar WTI contract. Several key fundamental factors of the oil market also are drastically different from 2008 and may help explain this result. First, using EIA estimates, OPEC spare production capacity is projected to be 2.7 million barrels per day higher in the first half of 2011 than in the first half of 2008. Second, crude oil inventories in the United States are near historic highs. Lastly, world economic growth, which is an indicator of oil demand growth, is expected to average 3.6 percent in the first half of 2011. This is below the 4-6 percent growth that the world economy saw from 2005 through first quarter of 2008. Thus, there is considerably more "slack" in crude oil production and inventory levels compared to 2008 and lower projected demand. These factors support the market's opinion of a low probability of seeing a sharp rise in oil prices this summer; however, geopolitical events, weather, or other unforeseen events could increase the chance of prices rising rapidly.

Question 3b. Do any of the witnesses believe that putting some limits on excessive speculation reduces the changes of rapid rise in oil prices similar to the summer of 2008?

Answer. Position limits on energy futures, which are in the process of being developed by the Commodity Futures Trading Commission pursuant to last year's Dodd-Frank financial reform legislation, are intended to prevent one entity from obtaining an undue influence on a market. EIA has not evaluated the specific consequences of position limits on oil price movements. Nonetheless, the effect of position limits on future price movements will depend in part on the degree to which prices—in the absence of such limits—would be driven by the actions of individual market entities or rather by broader market trends and behavior.

Question 3c. Recent years have provided us with plenty of fresh evidence that markets are susceptible to irrational behavior, both exuberance and fear. We have seen this not only in energy markets, but in financial markets in general, whether for securities, home mortgages, or other commodities. Can you please comment on how, and whether, your organizations attempt to incorporate market forces into your energy pricing models?

Answer. EIA examines supply, demand, economic growth, futures markets, and other market forces, as well as other analysts' forecasts, in its energy pricing analyses. EIA also quantifies the uncertainty, or risk, in the market by using "implied volatilities" derived from the NYMEX options markets to construct confidence intervals around the NYMEX crude oil futures prices. The confidence intervals are essentially a way of assessing the market's uncertainty around the current price paths, and thus, take into account all factors, including "non-fundamental" factors. Information from futures trading is also used to calculate probabilities of prices exceeding certain levels. These probabilities are included in a supplement to EIA's Short-Term Energy Outlook.

EFFECT OF NEW PRODUCTION TECHNOLOGIES ON PRICES

Question 4a. There seems to be some disagreement on whether investment in developing new production technologies ends up reducing the price of fossil fuels. We have heard a great deal about how oil and gas production is a capital intensive business that requires significant investment in new technologies to access new resources, whether those are unconventional resources, such as oil sands or shale, or hard to access resources, such as ultra-deepwater drilling.

Does investment in developing such hard-to-access resources result in lower fossil fuel prices? Or does it simply enable the production of harder to access and more expensive resources, thereby ensuring that oil and natural gas will only continue to flow as long as global prices remain high? Are you concerned that the U.S. is locking itself into dependence on a resource that is destined to get more and more expensive over time?

Answer. Private and national oil companies are using advanced technologies to bring unconventional oil and natural gas resources to market.³ There is no question that with these new technologies oil and natural gas prices are lower than they otherwise would be. No technology, of course, will be employed if it has a cost of production greater than expected market price. In the United States the expanded use of horizontal drilling and hydraulic fracturing technologies in tight sands and shale deposits have had very large impacts on U.S. natural gas supplies and they are beginning to have a noticeable impact on U.S. oil supplies.⁴ As there is not a world-wide natural gas market, beyond LNG, there can be considerable disparity of natural gas prices across different regions of the world.

Price is the market equilibrium of supply and demand. Improvement in production technology increases the technically recoverable resource. Reserves are determined by what portion of the technically recoverable resource is economical to produce. Producers use future price projections to evaluate what production technologies and resource plays are likely to result in the greatest return on investment.

Technological advances have lowered the cost of resource access and production for shale gas, shale oil and oil sands. EIA projects a doubling of natural gas production from shale gas formations and 20 percent higher natural gas production.⁵ These represent substantial improvements compared with the production and price forecasts in the EIA Annual Energy Outlook 2010 (AE02010) Reference case.⁶ The improvement in the U.S. natural gas outlook is much greater when compared to the widely held expectation of earlier years that the United States would have to rely on LNG imports.⁷

For oil produced from shale formations, company announcements and industry reports have noted that technology developments have reduced drilling time to an average of 24 days to drill a well in 2010, down from 56 days in 2006.⁸ The technology developments have made accessible new areas that were previously marginal drilling and exploration opportunities and made wells profitable at prices as low as \$50 a barrel, down from \$80 three years ago according to market analysts.⁹ For oil sands, technological developments are helping to hold down rapid increases in labor and capital costs which have pushed break-even prices to \$60-\$80 per barrel according to industry sources.¹⁰ These cost reductions are typical after advanced technologies are first deployed. Through a process often referred to as "technology learning," new technologies usually achieve a steady reduction in cost with expanded commercial deployment. As other unconventional technologies are deployed to develop harder-to-reach oil and gas resources, we can expect that this process of technology learning will continue with each new innovation.

It is less important whether the cost of unconventional oil and gas development is ever competitive with the easy-to-reach oil and gas resources of the past. The real test is whether they remain competitive in the oil and gas markets of the future. The investments being made by private and national oil companies indicate a high degree of confidence that they will, although there is always the possibility that oil or natural gas prices could fall sufficiently to make these investments unprofitable, at least temporarily. These risks are not fundamentally different than those that have to be considered by any investor.

³The Bakken Formation of the Williston Basin is a success story of horizontal drilling, fracturing, and completion technologies. EIA, Technology-Based Oil and Natural Gas Plays: Shale Shock! Could There Be Billions in the Bakken?

⁴EIA estimates U.S. natural gas production from shale was 3,110 billion cubic feet (bcf) in 2009 out of a total U.S. marketed natural gas production of 21,604 bcf. Oil production from the Bakken formation by the end of 2010 reached 458,000 barrels per day, outstripping the capacity to ship the oil from the region. (Bentek Energy) By comparison, in November 2010, total U.S. crude oil production was 5.595 million barrels per day. (EIA)

⁵AE02011 Early Release, 2035, lower-48 states.

⁶EIA, AE02011 Early Release.

⁷The Annual Energy Outlook 2004 projected that, by 2025, 7.2 TCF, or 22%, of domestic consumption, would be met by natural gas imports.

⁸Wall Street Journal, February 26, 2010, Oil Industry Booms—in North Dakota

⁹Ibid.

¹⁰Business Week, June 2, 2010, Production Costs Climb for Canadian Oil Sands, Companies Say

Question 4b. Do you believe there is now a new normal for fossil fuel prices? Just a decade ago OPEC had a \$22 to \$28 a barrel target range. In 2004 Ali Naimi, the Saudi oil minister, called \$30 to \$34 a barrel a “fair and reasonable price” for oil. Why is the world now so willing to accept considerably higher levels of fossil fuel prices?

Answer. Recent statements from OPEC members have identified “fair and reasonable” price levels significantly higher than the price range they discussed a few years ago. Saudi Minister Al Naimi stated in January 2011 that a \$70-\$80 oil price range was fair for the world market. Some OPEC members appear to be targeting price levels even higher than indicated by his statement. In January of this year, Iran, Libya and Venezuela (all members of OPEC) identified \$100 a barrel as a fair market price.

Rapidly rising oil consumption in non-OECD (Organization for Economic Cooperation and Development) countries is one important reason for higher oil price levels. Oil consumption in non-OECD countries soared 40 percent from 2000 to 2010, an absolute increase of approximately 12 million barrels per day (bbl/d). Developing countries often see a smaller demand response to higher prices due in part to the widespread existence of oil product subsidies. OECD countries, on the other hand, had decreasing oil consumption during the last decade, which fell from 48 bbl/d in 2000 to less than 46 bbl/d in 2010. On the supply side, oil producers are exploring and developing reserves in more costly areas, including deep water and oil sands. The combination of rising demand and more costly supply has been the major factor in price levels beyond those seen a decade ago.

ROLE OF ENERGY EFFICIENCY

Question 5a. Can you please talk about the role of energy efficiency standards—for lighting or vehicles or otherwise—in your reference case? What assumptions are made as to how future efficiency standards enacted via legislation or a rulemaking process will impact future fossil fuel consumption levels?

Answer. The Annual Energy Outlook 2011 Reference case includes, for light-duty vehicles, the attribute-based Corporate Average Fuel Economy (CAFE) standards for model year (MY) 2011 and CAFE and greenhouse gas emissions standards for MY 2012-2016 as promulgated by final rulemakings. The MY 2011 minimum fuel economy requirement increases from 25.6 mpg in MY 2010 to 27.3 mpg in MY 2011 and to 34.1 mpg in MY 2016. CAFE standards are assumed to further increase in the Reference case to a combined 35 mpg for MY 2020 as mandated by the Energy Independence and Security Act of 2007. In the Reference case, CAFE standards are held constant in subsequent model years, but the minimum requirement is exceeded over the projection period due to the continued adoption of advanced technologies, with new vehicle fuel economy reaching 37.8 mpg by 2035.

The Annual Energy Outlook 2011 Reference case also includes energy efficiency standards for residential and commercial equipment that have been promulgated by the U.S. Department of Energy, legislated by Congress, or agreed upon by manufacturers and other interested parties. Many major end-use devices in buildings are covered by efficiency standards. When a new or revised standard goes into effect, equipment that does not meet the efficiency standard is assumed by EIA to be no longer available. Impacts on future fuel consumption increase over time as worn-out equipment is replaced and equipment is purchased for new buildings. In the industrial sector, minimum efficiency standards for motors also reduce fuel consumption. In the Reference case, increased energy efficiency lowers energy consumption about 13 percent from where it otherwise would be in 2035. The full AEO, to be released this spring, will include a range of sensitivity cases that alter the assumptions about energy efficiency improvements and consider the impact of extensions of energy efficiency policies.

Question 5b. There have been recent legislative proposals to overturn the U.S. lighting efficiency standard enacted in the Energy Independence and Security Act of 2007. I have seen analysis showing that this single policy will result in the United States foregoing the need for 30 additional large power plants and consumers will collectively save more than \$10 billion on electricity bills each year. Do you agree with that analysis and how would repeal of this lighting standard affect your long-term modeling results?

Answer. By 2020, residential lighting technologies in the Annual Energy Outlook 2011 (AEO2011) Reference case are three times more efficient than those marketed today due to lighting standards in the Energy Independence and Security Act of 2007. EIA has not analyzed the lighting standards in isolation. However, average annual lighting use per household falls 622 kilowatt-hours (kWh) between 2011 and 2025 in our projections, from 1,757 kilowatt hours (kWh) to 1,135 kWh. Projected

lighting energy use for all 135 million U.S. households in 2025 is 153 billion kWh in our Reference case projection. If per-household lighting energy use in 2025 remained the same as in 2011, projected aggregate electricity use for residential lighting would be about 84 billion kWh higher in 2025. While translating this into the number of power plants potentially avoided is complicated, if one were to assume that on average each gigawatt of capacity generates about 6 billion kWh, the 84 billion kWh reduction in lighting use would eliminate the need for about 14 gigawatts of new capacity or about 28 500-megawatt generating units. Regarding electricity bill savings, this amounts to about \$9 billion per year in lower electricity bills when priced at the AE02011 residential electricity prices of 10.5 to 11 cents per kWh, although this does not include the additional up-front cost for more expensive lighting.

U.S. OIL DEMAND CURVE

Question 6a. I found one of the most interesting trends across your collective forecasts is the flat, or even declining, demand for oil in developed countries, including the United States, over the next 25 years.

Mr. Burkhard's testimony notes that CERA believes aggregate oil demand in developed markets peaked in 2005 and will not exceed that level again.

The IEA predicts U.S. oil demand will drop by 10% by 2035.

The EIA reference case predicts that total liquid fuel consumption in the U.S. will increase 17%, to 22.0 million barrels per day, but all of that increase will come from biofuels. Oil demand appears essentially flat or falling.

If Congress and the Bush and Obama Administrations had failed to enact these policies, how likely is it that forecasted U.S. oil demand would be falling over the next 25 years?

Answer. If vehicle fuel economy standards had not been increased during the past decade and policies that support and/or require biofuels production and consumption had not been enacted, then U.S. total liquids consumption would be higher than the 22 million barrels per day in 2035 projected in EIA's Annual Energy Outlook 2011 Reference case. Without these policies, U.S. biofuels production and consumption would be lower and thus oil consumption would be increasing instead of being essentially flat.

Question 6b. If Congress and the Administration had failed to enact these policies, what would you anticipate would be the effect on global oil prices in 2035, compared with your reference case?

Answer. If these fuel economy and biofuels policies had not been enacted—which effectively reduce demand for oil—then global oil prices would be higher in 2035 compared with the \$125 per barrel (2009 dollars) in the Reference case.

MEETING RENEWABLE FUELS TARGETS

Question 7a. I am discouraged by EIA's prediction that the market will be unable to meet the targets set forth in the RFS-2, which is the revised Renewable Fuels Standard that Congress passed 2007.

That standard mandates production of thirty six-billion gallons of biofuels a year by the year 2022, sixteen billion gallons of which must be of "cellulosic" origin.

Your agency's analysis states that: "EIA's present view of the projected rates of technology development and market penetration of cellulosic biofuel technologies suggests that available quantities of cellulosic biofuels will be insufficient to meet the renewable fuels standards targets for cellulosic biofuels before 2022."

In EIA's analysis, what are the primary barriers to achieving the RFS targets? Are they on the supply side—simply producing enough fuel? Or are there also barriers on the demand side—creating an adequate distribution infrastructure and enough flexible fuel vehicles on the road?

Answer. The expected shortfall in meeting the cellulosic biofuels targets primarily reflects high production costs and technological challenges that are exacerbated by current market and regulatory conditions. Some observations that support this statement include:

- Technological progress on process yields and scaling up designs has been observed to be slower than initially anticipated. At least 6 planned facilities have delayed startup by 6 months or longer, while only 3 plants have reached the startup phase—with many more awaiting financing.
- Many in the industry have been observed to face important financial, legal, and technological issues that have yet to be resolved. Recent bankruptcy, plant closure, and repeatedly missed production goals are examples of serious setbacks for companies identified by the EPA as potential cellulosic suppliers in 2011.
- The recent financial downturn has also been cited by technology developers as a reason for the reduction in private investment in the technology. Studies show

that capital costs have risen significantly above the original expectations for these technologies. In addition, biomass feedstock costs have also been substantially higher than originally expected and process yields have not achieved goals.

The slow market penetration of the technology has led to the EPA granting waivers for large shares of the cellulosic biofuels mandates for 2010 and 2011. This in turn has made EPA cellulosic biofuels credits available to obligated parties at a cost significantly less than the current production cost for the technology.

On the demand side, EIA's projections do not assume a near-term infrastructure constraint in marketing the ethanol that is produced. The majority of U.S. corn ethanol production and smaller volumes of imported ethanol and cellulosic ethanol are assumed to be absorbed in E10 and recently-approved E15 gasoline blends. In addition:

- After the E15 blend pool is saturated by 2020, new volumes of ethanol are assumed to be sold as E85—with the partial resolution of some infrastructure barriers—and Flex-Fuel Vehicles are assumed to be more widespread.
- E85 is assumed to be sold at a discount factoring in its lower energy density compared to motor gasoline, with E85 selling for \$2.87 per gallon vs. \$3.64 per gallon for gasoline in 2030. E85 volumes thus increase from 0.1 billion gallons in 2020 to over 9 billion gallons at the end of the forecast (2035).

A number of next-generation biomass-to-liquid technologies, including clean diesel fuel produced from cellulosic biomass, are assumed to be “drop-in” fuels that can be distributed and consumed using existing infrastructure and vehicle fleets and do not face significant infrastructure hurdles. These fuels contribute to the overall level of cellulosic biofuels in EIA's projections.

Question 7b. Does EIA's analysis include cellulosic biofuels other than ethanol? For example, does it include the possibility that the RFS-2 mandate might be met with other cellulosic fuels such as methanol?

Answer. The majority of cellulosic biofuel consumption growth is projected to come from cellulosic ethanol. However, the Annual Energy Outlook 2011 Reference case also projects the penetration of Biomass-to-Liquids (BTL) technologies that use cellulosic biomass to produce other motor fuels. These next-generation technologies yield fuels that can be distributed and consumed using existing infrastructure and vehicle fleets.

While methanol is not an approved RFS-2 pathway for direct use in transportation fuels under current rulemakings, EPA has indicated that it would allow cellulosic Renewable Identification Numbers (RINs) to be generated for qualified cellulosic methanol feedstock used in biodiesel production based on its ethanol-equivalent energy value (approximately 0.75 RINs per unit of methanol or 0.1 RIN per gallon of biodiesel). Since volumes are expected to be very small and are currently only being produced in testing phases, the AE02011 does not explicitly model a cellulosic methanol RFS credit.

Question 7c. Do you believe there will be enough flexible fuel vehicles available in America in 2022 to be able to consume biofuels production mandates in the RFS-2?

Answer. The Annual Energy Outlook 2011 Reference case projects that 41 million flex-fueled vehicles will be on the road in 2022, representing about 16 percent of the total light-duty vehicle stock. These flex-fueled vehicles could consume 27.5 billion gallons of E85 in 2022, if fueled entirely by that fuel. The actual ethanol content of E85 fuel varies by region and season and typically averages well under 85 percent, with petroleum gasoline making up the difference. Using the assumption that 75 percent of E-85 is actually ethanol, if all flexible fuel vehicles were fueled with E85 nearly 21 billion gallons of biofuels could be consumed. Biofuels are also blended into motor gasoline and diesel fuel, with ethanol blending into motor gasoline being by far the most significant. Ethanol can be blended into motor gasoline to up to 10 percent of volume and up to 15 percent of volume for light-duty vehicles from model year 2001 and later. The Annual Energy Outlook 2011 Reference case projects that over 17 billion gallons of ethanol will be blended into motor gasoline in 2022. If sufficient production was available, ethanol blended into motor gasoline and E85 consumed in flex-fueled vehicles could in principle reach approximately 38 billion gallons by 2022, surpassing the total 36-billion-gallon RFS-2 mandate.

IMPLICATIONS OF BUSINESS AS USUAL

Question 8. One thing I found lacking from most of the analyses was any kind of discussion of their broader implications. For example, what kind of world will we

live in 2035 if the forecasts contained in the reference cases prove accurate, a world that consumes 107 million barrels of oil per day.

. . . I completely agree. Energy policy raises complex questions of equity and justice. I believe that too often people who point to the unsustainable nature of our energy system are labeled as “anti-growth”. For all our sakes, I hope we can begin to move beyond such characterizations, and start talking about policy that can foster both growth and sustainability.

Would you please comment on the implications of continuing our business as usual trajectory (i.e. the trajectory outlined in the EIA reference case)?

Answer. The Energy Information Administration (EIA) includes information regarding the economic and energy implications of the Annual Energy Outlook Reference case. The broad implications are summarized below.

The U.S. real gross domestic product grows by an average of 2.7 percent per year from 2009 to 2035 in the Annual Energy Outlook 2011. The Nation’s population, labor force, and productivity grow at annual rates of 0.9 percent, 0.7 percent, and 2.0 percent, respectively, from 2009 to 2035. Assuming no changes in policy related to greenhouse gases, carbon dioxide emissions grow slowly, but do not again reach 2005 levels until 2027.

Although energy-intensive industries are expected to recover rapidly from the recent recession, long-term growth is slowed by increased competition from overseas manufacturers and a shift in U.S. manufacturing toward higher-value consumer goods which are less energy-intensive to manufacture. Net imports of energy meet a major, but declining, share of total U.S. energy demand. The projected growth in energy imports is moderated by increased use of biofuels (much of which are produced domestically), demand reductions resulting from the adoption of new efficiency standards, and rising energy prices. Rising fuel prices also spur domestic energy production across all fuels, particularly natural gas from plentiful shale gas resources, and temper the growth of energy imports.

It is important to note that the EIA Reference case is based on current laws and regulations and thus does not assume new policies, such as increased fuel economy standards, changes in access policy for domestic resource development, a Clean Energy Standard, or any new climate change policies. This practice is necessary to provide a clear reference point and to avoid speculative policy assumptions, and it serves as a starting point for analysis of potential changes in energy policies, rules, or regulations through the uses of alternative modeling cases. The EIA Reference case therefore is meant to provide an outlook where the assumptions and implications are clearly understood, but not necessarily as the world might unfold.

INVESTMENT LEVELS NEEDED IN NEXT HALF CENTURY

Question 9. Has EIA done a comparable analysis [of the amount of worldwide investment that might be required over the next half-century to prevent energy shortages and greenhouse gas emissions from undermining global economic growth] that could be used for comparison [with the TEA figure of \$45 trillion]?

Answer. EIA has not developed an estimate of the future investment required in the world energy supply infrastructure nor has it considered how such an estimate might be affected by policies to limit greenhouse gas emissions. There are few publically-available sources of international statistics that would allow EIA to confidently make such estimates. In general, worldwide statistics on the costs associated with installing energy infrastructure are costly and difficult to obtain. Thus, without making heroic assumptions about current and future global costs associated with an array of potential energy infrastructure projects, EIA would be unable to derive such estimates either in the present or in the long-term future. However, EIA’s U.S. Annual Energy Outlook Reference case projections and additional analysis cases provide extensive information regarding U.S. energy infrastructure requirements.

IMPACT OF GREENHOUSE GAS REGULATIONS

Question 10. Now that the Environmental Protection Agency has begun to implement regulations to limit greenhouse gas emissions from stationary sources, how has that impacted EIA’s modeling results? What assumptions has EIA incorporated into its modeling runs to account for these EPA regulations in terms of greenhouse gas emissions reductions relative to 2005 levels? If EIA has yet to incorporate these new regulations, does the agency plan to in the future?

Answer. While EPA is developing regulations pertaining to greenhouse gas (GHG) emissions from stationary sources, it has not released specific standards for the various types of power plants and energy-using industrial facilities. Without such standards, EIA cannot effectively model the impacts of EPA’s proposed regulations.

EIA is monitoring EPA's progress in developing the rules, and when more information on the specific standards is available, we will adjust our analysis accordingly.

EIA does try to capture current market behavior in its modeling with respect to concerns about GHG emissions and their potential regulation. In order to account for the market's uncertainty surrounding investment decisions in GHG-intensive technologies, EIA assumes a 3 percent premium in the cost of capital for new coal-fired power plants and other GHG-intensive technologies, which is one factor that leads to few new coal plants beyond those already under construction being added to the AE02011 Reference case projection. In addition, 10 states in the Northeast are participating in the Regional Greenhouse Gas Initiative (RGGI) cap and trade program and this is represented in the EIA analyses. Most states participating in the program have already met their state level caps.

HOW TO INCREASE ENERGY DIVERSITY

Question 11a. A common theme across all the witness testimony is that global energy demand is increasing and fossil fuel prices are likely to continue to increase. So it seems like if the U.S. continues to ignore this problem, the economic and security impacts will be significant. The witnesses also all seem to agree that diversifying America's sources of energy is a key way to mitigate these harmful impacts.

What are the most economically efficient policies to increase U.S. energy diversity without the need for government to pick technology or special interest winners or losers?

Answer. The most effective policies are those which clearly define the attributes or requirements that the Nation wants to achieve to address energy security, economic growth, and climate change. A technology-neutral approach, such as the Clean Energy Standard (CES) proposed by President Obama in the State of the Union, which seeks to double the share of electricity from clean energy sources by 2035 to 80 percent, is an example of such a policy. Under a CES, as proposed by President Obama, any technology that uses energy in a clean, efficient way will have the opportunity to advance.

The President has also outlined a portfolio of actions which, taken together, could cut U.S. oil imports by a third by 2025. These include programs that would increase the fuel economy of our cars and trucks, put one million electric vehicles on the road by 2015, and increase the use of nonpetroleum fuels.

Question 11b. Do you agree with many energy experts who argue that a predictable price on carbon designed in a way that minimizes price volatility is the most economically efficiency and technology neutral way to realize greater energy efficiency and diversity?

Answer. A predictable, long-term price on carbon that minimizes volatility is one way that the actual costs of fuels usage can be reflected in their prices and one way to transform the energy system toward cleaner and more secure energy sources. However, other policies can assist in this transition in a cost-effective and technology neutral way. For example, the President's proposed Clean Electricity Standard would create a broad, technology-neutral incentive to transform the power sector, and many other policy options exist to increase the efficiency of energy consumption in end-use sectors.

Question 11c. Are there links between policies to reduce greenhouse gas emissions and increasing energy diversity? If such policies are successful in significantly reducing world demand for fossil fuels, what impact on future prices is that likely to have?

Answer. Policies that reduce greenhouse gas emissions will generally lead to greater deployment of cleaner and more secure energy technologies. If the transportation sector, for instance, gradually transitions away from petroleum through electrification, it will be important to encourage cleaner sources of electricity to maximize the environmental benefits of this transition, and the diversity of the energy supply increase as a result. Such transformation could be achieved through policies like the President's proposed Clean Energy Standard, coupled with policies to promote electric vehicles. If global fuel consumption declines, this would put downward pressure on global prices for such fuels, but the actual outcome will also depend on trends in global supply.

RESPONSES OF RICHARD H. JONES TO QUESTIONS FROM SENATOR CORKER

Question 1. Your organization has looked extensively at fossil fuel consumption subsidies. Does the U.S. pay any consumption subsidies and if so, how much, and how is that related to the price consumers pay for petroleum?

Answer. Using the price gap methodology, which compares international market prices for fossil-fuels with end-use prices paid by consumers, the IEA does not measure any fossil-fuel consumption subsidies paid by the United States. The United States does, however, administer a targeted program to assist low-income households with immediate home energy needs through the Low Income Home Energy Assistance Program (LIHEAP). This is not captured by our measurement approach since it does not affect the pricing of energy products, but it does support fossil-fuel and other energy consumption.

Question 2. If we were to look at all the costs paid by the U.S. Government to manage supply lanes and ensure the safe transport of crude, what would the true price of petroleum be? Are these costs reflected in any way in the price that consumers pay, and what would happen to the price per gallon of petroleum if these support measures were to be eliminated?

Answer. Crude oil prices comprise many elements, ranging from short term market fundamentals, oil refining bottlenecks, perceptions of future supply/demand, macro and micro-financial influences and geopolitical risks. To the extent that the protection of supply lanes lowers the perception of risk in producing or transit areas it would also lower the international crude oil price. One can only guess at the extent to which this component of international prices might change if sea lanes were not kept clear, but *ceteris paribus*, were less resources dedicated to ensuring the secure movement of oil supplies, then crude prices might well rise.

RESPONSES OF RICHARD H. JONES TO QUESTIONS FROM SENATOR MURKOWSKI

SUEZ CANAL

Question 1. You said in a recent interview with the Financial Times that you've heard reports of "difficulties in providing security for some of the crews passing through the Suez Canal. And of course, if there is a blockage of the Suez Canal, that would be cause for concern." Can you tell us what, exactly, you've heard about security concerns in that region? Do they remain?

Answer. The Suez Canal is a choke point for transport of many commodities, including crude oil and petroleum products. The blockades in 1956-1957 and 1968-1975, when some 10% of global oil trade passed the Suez Canal, caused oil prices to spike and triggered economic downturn. Therefore oil market participants are still closely watching the Suez Canal and react nervously to any news of interruptions. Times have changed however. The introduction of Very Large Crude oil Carriers (VLCCs) in the early seventies resulted in more crude oil transport around Cape of Good Hope of Africa, so nowadays less than 1% of the crude oil production is transported through the Suez Canal, in almost balanced quantities going north and south. So the cause of concern is not so much a loss of crude oil supply (in fact no oil would be lost, but transportation time and costs would go up), but the Suez Canal is in the heart of the Middle East, the dominant oil producing region, and any increased tension in the Middle East results in nervousness on the oil market. For example, the specific press reports referenced in the FT interview turned out not to be significant.

SUBSIDIES

Question 2. Your organization has been quite active in opposing fossil fuel consumption subsidies. Do you believe the U.S. government offers any fossil fuel subsidies? What are they and what would be some of the consequences if these were removed? Would you describe LIHEAP—financial assistance for heating oil purchases—as the sort of consumption subsidy which IEA supports ending? Between consumption subsidies and production incentives, which result more directly in increased consumption of fossil fuels?

Answer. The US government offers some fossil-fuel subsidies; most are on the production side. Although not captured by our methodology for measuring fossil-fuel consumption subsidies, where we compare international market prices for fossil fuels with end-use prices paid by consumers, the targeted Low Income Home Energy Assistance Program (LIHEAP) supports fossil-fuel and other energy consumption. We do not recommend phasing out subsidies that are well-targeted and assist the poor with the most basic of energy needs.

The IEA has not attempted to quantify US subsidies to fossil-fuel production, but these do exist within our broad definition of energy subsidies which is "any government action that lowers the cost of energy production, raises the price received by energy producers or lowers the price paid by energy consumers". Instruments used to confer support to fossil-fuels production are often tax incentives, including for the US: limiting taxable income based on percentage depletion of oil and gas reserves,

allowing the expensing of intangible drilling costs, and domestic manufacturing deductions. The IEA has not tried to measure the effect on energy production of phasing out these subsidies, although they would increase costs for producers to some extent.

US ENERGY COMPANIES VERSUS NATIONAL OIL COMPANIES (NOCs)

Question 3. Can you describe how U.S. oil and gas producers operate with any disadvantages relative to National Oil Companies such as the OPEC owner companies?

Answer. IOCs (including US companies), which have traditionally dominated the global oil and gas industry, are increasingly being squeezed by the growing power of the national companies and by dwindling reserves and production in accessible mature basins outside OPEC countries. The main advantage held today by NOCs over IOCs is access to reserves. We may see stronger partnerships between the national and international oil companies in the future to ensure adequate oil and gas supplies in the long term. The mutual benefits that could accrue are compelling: the national companies control most of the world's remaining reserves, but in some cases lack the technology, capital and/or skilled personnel to develop them efficiently; the international companies are opportunity-constrained, but have the finance and management skills, and technology to help national companies develop their reserves.

OIL MARKETS

Question 4. If only about 3 percent of the world's oil travels through the Suez canal and the SUMED pipeline, yet we are seeing some influence on the global commodity price resulting from instability around the Suez, does this indicate that seemingly small disruptions, real or potential, can have comparatively large impacts on global markets?

Answer. It is true that because both the supply and demand for oil are slow to respond in the short term to changes in international prices, so relatively minor dislocations of supply or demand can have an exaggerated impact on price. But events in Egypt this last month have had an impact that went far beyond concerns over Egyptian infrastructure and transit routes. Concerns about contagion of political instability for the rest of the MENA region, where much of the world's oil and gas resources are concentrated, likely played at least as much of a role in influencing prices.

MAJOR OIL DISCOVERIES

Question 5. What was the impact on global investment and markets when the Tupi field was discovered off of Brazil in 2006, and how does the addition of a multi-billion barrel discovery impact the host nation and the industry?

Answer. The Tupi discovery has consolidated Brazil's position as one of the three main contributors to non-OPEC supply growth over the next decade. Major oilfield announcements tend to affect the share price or valuation of individual companies concerned, rather than commodity prices per se. Brazil faces challenges in constructing infrastructure according to the ambitious schedule it has set itself, and in managing windfall oil revenues once production starts in a major way.

CRISIS-DRIVEN ENERGY POLICY

Question 6. The Outer Continental Shelf Lands Act was implemented after the Arab oil embargo and subsequent price controls and economic shocks of the 1970's, as was the authorization of the Trans-Alaska Pipeline System. Are these patterns of crisis and response as an unavoidable trend in U.S. energy policy?

a. Is the U.S., in your group's view, more proactive or reactive in its energy policy?

Answer. After the Arab oil embargo and the creation of the International Energy Agency (IEA), all Member countries of the IEA committed themselves to a number of actions to reduce their oil (import) dependency. The actions taken differed, according to the circumstances of the country. Those countries that could increase domestic production did so, like the US, but notably also countries in Western Europe, who started successfully exploring the North Sea.

Also all IEA countries implemented energy savings and energy efficiency programs.

The efforts of the Member countries have been reviewed over the last 35 years during a series of Energy Reviews and Emergency Response Reviews (each con-

ducted in a 5 year cycle). Generally speaking, the crisis response measures of the United States are well developed and the Strategic Petroleum Reserve of the United States is a valuable asset for the country and for the group of IEA Member countries as a whole.

CLEAN ENERGY STANDARD

Question 7. Should we learn a lesson from the Renewable Fuel Standard, which has fallen short of expectations, when considering an aggressive electricity mandate like the one the President is calling for? How likely is it that we will create unforeseen problems if we put a CES in place? To name just one example, will transmission problems—and our inability to add significant amounts of renewable energy to the grid—become the new “blend wall”?

Answer. Ambitious targets for low-carbon electricity, especially at the federal level, as announced by President Obama, are important signals of the USA’s willingness and determination to move the country onto a sustainable energy trajectory. The 450 Scenario of the IEA’s World Energy Outlook 2010 details a medium-term carbon-constrained energy pathway, which projects that 89% of the United States’ power output could be zero or low-carbon by 2035 given concerted policy support. [NB: the WEO’s definition of “zero or low” carbon energy is much stricter than the definition given by President Obama: the WEO only includes fossil fuel generation with CCS, while President Obama’s CES proposal includes ‘clean coal’ in general and ‘efficient natural gas’.]

Carefully defining the Clean Energy Standard (CES) and its eligible technologies, possible technology set-asides and interim targets are crucial first steps to boosting investor confidence. Given that a majority of US states already have renewable portfolio standards in place, the effective implementation of a federal clean energy standard will require careful coordination and a predictable and transparent transition that avoids disadvantaging existing clean energy investments.

Targets must be supported by an effective system of financial and non-financial incentives to ensure appropriate conditions for exploiting the large potential for clean energy technologies. These clean energy technologies, including renewables, such as wind and solar, are generally not yet as mature and cost-competitive as conventional carbon-intensive generating technologies, but their costs are declining rapidly thanks to increasing economies of scale and technology learning gained through significant market deployments with targeted policy support.

Doubling the contribution of clean energy technologies to the USA’s generation mix by 2035 is evidently a tremendous challenge requiring a systems approach to ensure sustainable market growth while controlling overall cost, both in terms of policy support and technical infrastructure. Upgrading and expanding existing grids to keep pace with capital stock turnover in the power sector is a fundamental challenge regardless of the specific type of generation technologies entering the mix. As part of this challenge, in parallel to the introduction of a Clean Energy Standard, the system integration of variable renewable energy technologies, such as wind and solar PV, needs to be assessed carefully. However, the IEA’s research suggests that the capacities of grids, based only on current resources and improving operational measures, are usually broad enough in most cases, e.g. in the Western US grid, which we have analysed in detail.

ALTERNATIVES TO OIL

Question 8. How substantial of an impact do you believe advanced biofuels, electric vehicles, and other technologies will have on petroleum consumption by 2020? By 2030?

Answer. IEA analysis shows that there is tremendous potential to cut transport oil demand in the 2030 time frame. However, this will depend heavily on the policies deployed over this period, as well as on the success of improving and lowering the costs of key technologies that are still in the development phase, such as for advanced biofuels and batteries. In our baseline projections (which assume that no new policies are introduced by governments), biofuels and EVs do not take sufficient market share to save very much oil by 2030.

However, in a world committed to low-carbon and lower-oil dependence futures, we believe there could be a substantial shift away from oil by 2030, with some of this shift in evidence by 2020. For example, in our WEO 2010 and ETP 2010 reports (which are consistent), our low CO₂ scenarios show a reduction in global transport oil use, compared to our baseline projection, of 150 million tonnes (about 7%) in 2020 and 600 million tonnes (about 30%) in 2030. Through 2030, substantially more than half of these reductions are attributable to improved energy efficiency across a range of vehicles and modes (cars, trucks, aircraft etc), including strong improve-

ments to internal combustion engines (such as hybridization). About 10% of the oil savings in 2030 are attributable to biofuels, and another 10% from electric vehicles. Other alternative fuels, such as natural gas, also play a role. However after 2030 the contributions from EVs and biofuels rise rapidly. With the right policy framework we believe that these technologies can become fully competitive, and in fact dominant, by 2050.

Realising a 30% cut in transport oil use relative to the baseline projection by 2030 would have enormous benefits for energy security, less air pollution in cities and the climate. It could also help restrain oil prices. For these reasons, the IEA is committed to helping countries move onto such a pathway.

FOREIGN OIL DEPENDENCE

Question 9. If Congress had allowed the Coastal Plain of ANWR and other parts of Alaska to be opened to production, in 1995 for example, we would be producing domestic oil at a considerably higher rate. What would that mean for our nation's energy security? Would we be more protected, or less protected, from civil unrest in Egypt, Jordan, and other parts of the Middle East? In the event of a supply disruption abroad, would we be better equipped, or less prepared, to deal with import shortages?

Answer. Generally speaking, if a country has more domestic oil production, it is less exposed to physical disruptions from abroad. At the same time, oil is traded on global markets, so a severe disruption can cause prices to rise in all countries, because the oil will flow to the highest bidder. So a country with more domestic production has less to fear that its oil supply will be disrupted when a major incident happens abroad, but prices may still rise, even in those countries that do not need to import any oil.

PROJECTED OIL PRICES

Question 10. In a hypothetical scenario of September 2012, with unemployment is down to 8.0%, the economy growing at greater than 3.0% each quarter, and world markets on the upswing, where would you forecast the price of oil?

Answer. The IEA does not forecast the price of oil. See below.

OFFSHORE MORATORIUM

Question 11. How does the amount of oil that could be taken offline by unrest in the Middle East compare to the amount of production that will be lost because of the absence of new exploratory permits in the Gulf of Mexico, and the absence of resumed exploratory operations?

Answer. In our short and medium term market analysis, we do not forecast oil prices. Rather our models are driven by the shape of the oil futures curve at the time that projections are made. However, the scenario you paint of strong global economic growth would likely be accompanied by strong oil demand growth and, because of the lead times necessary to develop new oil production capacity, by a narrowing margin of OPEC spare capacity. Our own medium term market outlook under a high economic growth scenario envisages OPEC spare capacity shrinking from around 6% of global demand in 2010 to less than 5% of global demand on average in 2012. Spare capacity would still be higher than the very low levels evident during 2004-2008, but nonetheless the very fact of a shrinking level of market flexibility suggests more volatile markets.

Our latest view is that 2015 US GoM oil production could turn out around 300 kb/d lower than we previously forecast because of delays in new field developments and to drilling required to sustain production at older fields. Those volumes could be higher if drilling remains at markedly lower levels for longer or new drilling is banned altogether in prospective resource-bearing areas. However, they would still probably pale in comparison to the amount of production that could be taken off line if political unrest were to disrupt production for a significant period in even one Middle Eastern exporting country.

ECONOMIC RECOVERY

Question 12. Adam Sieminski, the Chief Energy Economist for Deutsche Bank, recently wrote that "We estimate that a [10 dollar] rise in the oil price subtracts approximately 0.5 percentage points off U.S. growth." Do any of you agree with Mr. Sieminski's assessment?

a. Would this calculation change if the US supplied 60% of its own oil as opposed to importing 60% of its oil?

Answer. Our static analysis of oil price impacts on the US economy indicates that \$100 per barrel oil (on average) in 2011 translates to an import bill of \$385 billion at expected import levels (10.5 million barrels per day in our projections). This would be equivalent to roughly 2.6% of US GDP, approaching similar levels to those experienced in 2008, and risk undermining economic recovery. At \$110 per barrel in 2011, our estimate for the yearly US import bill would rise to \$425 billion (simplified using the same import and GDP levels in the calculation), or 2.8% of US GDP. The calculation provides only a rough estimate, but supports the notion that a \$10 swing in oil prices can have a major effect on the economy. The import bill we calculate, and thus its relation to GDP, depends on volume of net imports rather than the percentage of imports or domestic production. Assuming that domestic production accounted for 60% of US oil consumption at levels we project for 2011, US net imports would amount to about 7.1 mb/d. With \$100 per barrel of oil, the import bill would then total \$260 billion for the year, or 1.7% of US GDP.

IMPACT OF FEDERAL POLICIES

Question 13. What role does the federal government's stimulus policies, and the Federal Reserve's second round of quantitative easing, have played in boosting commodity prices? Have these policies boosted the price of oil, and, if so, by how much?

Answer. Federal stimulus and QE2 could theoretically boost commodity prices through physical or financial transmission mechanisms (note, these are two very different policies; the former is fiscal while the latter is monetary). Both may have demand side impact on commodities, but it is simply not possible to attribute specific price effects.

Insofar as stimulus and QE have buoyed economic activity in the US and abroad, physical demand for commodities would tend to rise and prices would increase, all other factors being equal. Both US economic growth and oil demand came in higher than expected in 2H10, one factor behind tightening global fundamentals and rising oil prices. However, it is difficult to isolate the effect of these policies on the economic rebound and on oil prices, particularly given the cyclical recovery in US oil demand that had already been underway since early-2010 and overarching role of global supply/demand fundamentals in tightening the physical market.

On the financial side, QE2 could potentially boost commodity prices through the exportation of currency inflation to dollar-pegged economies or through increased financial flows into commodities and emerging markets. Price pass-through resulting from the former mechanism could ultimately manifest itself through physical fundamentals, with currency inflation in emerging markets acting to stimulate oil demand. Increased capital flows into emerging markets could also stimulate higher levels of economic activity, thus raising oil demand and prices. However, it is unclear the degree to which QE2 itself has inflated developing economies. The domestic monetary policy of such countries probably plays a larger role and, indeed, several large economies (e.g. China and Brazil) have already begun tightening interest rates in order to cool economic expansion. Finally, while increased financial flows into commodities may amplify oil price movements in the short-term, there is little empirical evidence quantifying the effect of such flows. The linkage of oil futures markets to underlying physical markets also suggests that any such price dislocation brought about through purely financial reasons may be short-lived in any case.

OIL SPILL REPORT

Question 14. Have you reviewed the recommendations made by the President's Oil Spill Commission? Have you conducted any analysis on the impact those recommendations, if fully implemented, would have on domestic oil production, our import levels, and the global price of oil?

Answer. No, we have not connected an analysis of the possible impact of these recommendations, beyond that mentioned above (see question on Offshore Moratorium).

MODULAR NUCLEAR REACTORS

Question 15. What role do you believe small modular nuclear reactors will have in meeting the global demand for electricity? What countries are moving forward with this technology and what countries are interesting in acquiring these reactors?

Answer. Small modular reactors are discussed in the joint IEA/NEA (Nuclear Energy Agency) 2010 publication Technology Roadmap/Nuclear Energy. Countries involved in developing the technology include: Argentina, China, Japan, Korea, Russia, South Africa and the United States. Companies involved include: Areva, Babcock & Wilcox, General Atomics, NuScale and Westinghouse. Two small units are known to be under construction in Russia, reportedly for deployment via barge to

a remote coastal settlement on the Kamchatka peninsula. Elsewhere, some other designs are well advanced, with initial licensing activities underway. Demonstration plants could potentially be in operation before 2020, if funding becomes available. However, no firm commitments have been made to date.

CHINA

Question 16. Can you shed light on what China's energy picture really looks like, not just for renewable energy, but also its future demand for oil, natural gas, and coal?

Answer. Over the past year or so we have just seen an historic re-ordering of energy heavyweights, with China surpassing the United States to become the world's top energy consumer. Already a major actor in global energy markets, it has become abundantly clear that the developments in China will be key to shaping the world's energy future. Chinese energy use was only half that of the United States in 2000. The increase in China's energy consumption between 2000 and 2008 was more than four times greater than in the previous decade. Prospects for further growth remain strong, given that China's per-capita consumption level remains low, at only one-third of the OECD average, and that it is the most populous nation on the planet, with more than 1.3 billion people. Consequently, developments on the global energy landscape remain highly sensitive to the various factors that drive energy demand in China, including prospects for economic growth, changes in economic structure, developments in energy and environmental policies, and the rate of urbanisation.

The momentum of economic development looks set to generate strong growth in energy demand in China throughout the Outlook period. In the New Policies Scenario, China's primary energy demand reaches two-thirds of the level of consumption of the entire OECD. In absolute terms, industry accounts for the single biggest element in the growth in final energy demand. China's electricity demand is projected to almost triple in 2008-2035, requiring capacity additions equivalent to 1.5 times the current installed capacity of the United States. During much of the period of its economic expansion, China was able to meet all of its energy needs from domestic production, but now a growing share is being met by imports. China has extensive coal resources, but in recent years has become a net importer. It has struggled to expand its mining and rail-transport infrastructure quickly enough to move coal from its vast inland reserves to the prosperous coastal areas where demand has been growing most rapidly. In the New Policies Scenario, China's net imports of coal increase to 2015, but the country once again becomes a net exporter towards the end of the Outlook period. Its oil imports jump from 4.3 mb/d in 2009 to 12.8 mb/d in 2035, the share of imports in demand rising from 53% to 84%. Natural gas imports also increase substantially to reach a share of 53% of demand in 2035, requiring a major expansion of pipeline and liquefied natural gas (LNG) regasification infrastructure.

China's growing need to import fossil fuels to meet its rising domestic demand will have an increasingly large impact on international markets. Similarly, if pursued vigorously, China's efforts to expand the use of clean energy could have far-reaching implications throughout the rest of the world. First, its drive to deploy clean energy will lower the cost of those technologies everywhere, made possible by the economies of scale achievable in such a vast market and the acceleration of learning rates bound to occur. Second, there will be strong effects on global trade. China will most certainly attain status as the leading exporter of clean energy technologies and we may see, like Japan's auto manufacturers have done, an internationalisation of Chinese clean energy firms and manufacturing of clean energy equipment in destination markets. Third, China will gain a firmer economic stake in global action to reduce greenhouse-gas emissions.

Note: The graph "China's share of the projected net global increase for selected indicators" has been retained in committee files.

RESPONSES OF RICHARD H. JONES TO QUESTIONS FROM SENATOR CANTWELL

EFFECT OF DOMESTIC DRILLING ON GAS PRICES AND FOREIGN OIL DEPENDENCE

Question 1. In response to the recent political unrest in the Middle East, and rising oil prices, we have heard familiar calls to expand domestic drilling in the United States—including offshore and in the pristine Arctic National Wildlife Refuge (ANWR)—typically with the claim that such actions will lower gasoline prices or reduce our dangerous over-reliance on foreign oil.

An Energy Information Administration (EIA) study from May 2008¹ projected the effects on oil prices of drilling in the Arctic National Wildlife Refuge. According to EIA's projections, in the most optimistic case, drilling in ANWR would reduce crude oil prices by approximately \$1.44 per barrel. I understand this would translate to approximately 3 to 4 cents per gallon of gasoline at the pump about 20 years from now.

It seems that EIA has found that drilling offshore would have a similarly negligible effect on prices. EIA issued an analysis in 2009 that examined the impact of maintaining the historical moratorium on drilling off the Atlantic, Pacific, and Eastern Gulf of Mexico. According to that analysis: "With limited access to the lower 48 OCS. . .there [would be] a small increase in world oil prices. The average price of imported low-sulfur crude. . .is \$1.34 per barrel higher, and the average U.S. price of gasoline is 3 cents per gallon higher."

Would you please comment on your views on the ability of expanded domestic drilling to affect world oil prices?

Answer. As noted already, crude oil prices are influenced by today's market conditions, but also by perceptions of how easy it will be to meet expected demand growth in the future. A widespread perception among industry players today is that it is difficult to expand the supply base rapidly, largely because of barriers to investment. For the most part, these concerns centre on key areas of low-cost resources being completely off limits to international investment (such as Russia and the Middle East). But improved access to known hydrocarbon resources within major consuming countries could also go some way to easing concerns about future supplies, thus potentially acting as a restraining factor on future oil price rises.

IS OPEC ABLE TO OFFSET ANY INCREASED DOMESTIC DRILLING?

Question 2a. IEA forecasts that most the growth in oil production will occur in OPEC Countries like Saudi Arabia, Iraq, Venezuela, UAE, Kuwait, Iran, Qatar, Nigeria, Libya, and Algeria—not exactly America's best friends or even regimes that support the basic rights of their citizens. I understand that IEA projects that by 2035, world dependence on OPEC oil will rise from 41 percent to 52 percent. That's a level not seen since the oil shocks of the early 1970s.

What can oil importing nations do to mitigate the national and economic security threat posed by such a high degree of dependence on OPEC?

Answer. To enhance their energy security, countries need to take near-term actions in five key areas: (i) promote energy efficiency; (ii) ensure adequate energy diversity by minimising dependency on any single fuel, single supplier or single transportation route/mechanism; (iii) improve oil market data transparency; (iv) maintain an adequate safety net for use in the case of a supply shortage; and (v) participate in global cooperation on emergency preparedness as an oil supply disruption anywhere in the world would result in severe knock-on effects throughout the entire market. In the longer term, the progressive decarbonisation of electricity generation and the introduction of alternative transportation technologies would also help by reducing the growth in demand for fossil fuels.

Question 2b. It seems that the policies in the bipartisan 2007 Energy Bill that have increased vehicle fuel economy and the use of biofuels are the only things that have helped reduce the forecast for U.S. oil imports in decades. What lessons can be learned from that?

Answer. Both fuel economy and the use of biofuels have the potential to significantly lower oil use in the US and elsewhere. Strong provisions in the 2007 Energy Bill have helped to leverage this potential. There are still other areas of strong potential to cut oil use, such as promoting electric and plug-in hybrid vehicles. The recent Obama administration initiatives appear to put the US on a strong course in this regard as well, with a target of 1 million plug-in vehicles on the road by 2015.

EFFECT OF SPECULATION ON OIL PRICES

Question 3a. Several of the testified that oil price movements can be explained by supply and demand fundamentals, and these explain the upward pressure we've seen in recent months. We often hear about the lack of a "conclusive" smoking gun that links oil price spikes to speculation in the derivatives markets.

However, as you may know, the recently-passed Dodd-Frank Act requires the Commodities Future Trading Commission (CFTC) to establish rules to eliminate excessive position limits. Unfortunately, the 180-day deadline for those rules has

¹ <http://www.eia.doe.gov/oiaf/servicert/anwr/results.html>

passed and the regulatory process of establishing position limits is still in the early stages, and the limits are planned to be phased in over time.

Can the witnesses please comment on the likelihood of seeing a huge oil price spike this summer of the magnitude that we saw in the summer of 2008?

Do any of the witnesses believe that putting some limits on excessive speculation reduces the chances of rapid rise in oil prices similar to the summer of 2008?

Question 3b. Recent years have provided us with plenty of fresh evidence that markets are susceptible to irrational behavior, both exuberance and fear. We have seen this not only in energy markets, but in financial markets in general, whether for securities, home mortgages, or other commodities.

Can you please comment on how, and whether, your organizations attempt to incorporate market forces into your energy pricing models?

Answer. We think that the rise in prices seen since September 2010 has in large part been rooted in a tightening of global market fundamentals, with oil demand having run ahead of supply to the tune of over 1 mb/d in 2Q and 3Q 2010. But a tightening market is not the same as a tight market. The first half of 2011 sees a market that still looks well supplied, with a cushion of flexibility provided by spare OPEC crude capacity and OECD refining capacity, plus levels of OECD oil inventories that still look comfortable. So the period through summer 2011 does not have the same precursors of surging prices that were evident in early 2008. Of course, in recent weeks uncertainties regarding future supply due to the ongoing turmoil in the region have also had a major impact on prices. How long this might persist depends on the course of political events which are impossible to forecast.

We are generally in favour of greater regulatory oversight of commodity futures and derivatives markets and of moves to enhance the visibility of trades both on and off exchanges. Measures aimed at reducing systemic risks are to be supported. But at the same time, regulators are aware that well functioning markets need liquidity, ease of price discovery and ample opportunities for physical market players to hedge price risks for the future. The concept of 'excessive' speculation is difficult to define, and we would argue in favour of caution as regards position limits, so as to avoid sharply curbing market liquidity. Arguably, the sharpest spell of short term commodity price volatility occurred in autumn 2008 when liquidity flooded out of the market. So there is a risk of unintended consequences from over-zealous regulation, although many regulators seem well aware of this issue.

EFFECT OF NEW PRODUCTION TECHNOLOGIES ON PRICES

Question 4. There seems to be some disagreement on whether investment in developing new production technologies ends up reducing the price of fossil fuels. We have heard a great deal about how oil and gas production is a capital intensive business that requires significant investment in new technologies to access new resources, whether those are unconventional resources, such as oil sands or shale, or hard to access resources, such as ultra-deepwater drilling.

Does investment in developing such hard-to-access resources result in lower fossil fuel prices? Or does it simply enable the production of harder to access and more expensive resources, thereby ensuring that oil and natural gas will only continue to flow as long as global prices remain high? Are you concerned that the U.S. is locking itself into dependence on a resource that is destined to get more and more expensive over time?

Do you believe there is now a new normal for fossil fuel prices? Just a decade ago OPEC had a \$22 to \$28 a barrel target range. In 2004, Ali Naimi, the Saudi oil minister called \$30 to \$34 a barrel a "fair and reasonable price" for oil. Why is the world now so willing to accept considerable higher level of fossil fuel prices?

Answer. It is less a case that investment in these new resources might perpetuate higher prices, more a case that failing to invest in new sources of supply would likely lead to still higher prices. International oil companies face barriers to investment. Much of the world's low cost oil is situated in countries which deliberately restrict access or limit extraction rates. So international companies have had to 'move up the cost curve'. Structurally, and in the long term, the marginal barrel of non-OPEC supply is likely to become higher cost. This will ultimately lead to policies which lessen dependence on oil in the longer term. But we cannot wean our economies off oil and other hydrocarbons overnight. So investment in new sources of oil and gas, even if they are higher cost, needs to be encouraged.

There are great dangers in heralding any concrete new 'range' for oil prices. Technology, changing economic circumstances and geopolitics often conspire to alter perceptions of what might constitute any new price 'norm'. Opportunity constraints, rising costs, stretching project lead times and producer revenue aspirations all pushed price perceptions higher in the last decade. And indeed in the longer term, the ex-

exploitation of more costly oil resources, and moves toward an effective price for carbon dioxide emissions could indeed lead to a sustained period of higher prices. But as the economic recession of 2008 showed, periods of sharply lower prices are also possible. In the short term, the global economic recovery would benefit from prices lower than currently, as the global oil burden is approaching levels which in the past have acted to curb economic activity.

ROLE OF ENERGY EFFICIENCY

Question 5. Can you please talk about the role of energy efficiency standards—for lighting or vehicles or otherwise—in your reference cases? What assumptions are made as to how future efficiency standards enacted via legislation or a rulemaking process will impact future fossil fuel consumption levels?

There have been recent legislative proposals to overturn the U.S. lighting efficiency standard enacted in the Energy Independence and Security Act of 2007. I have seen analysis showing that this single policy will result in the United States foregoing the need for 30 additional large power plants and consumers will collectively save more than \$10 billion on electricity bills each year. Do you agree with that analysis and how would repeal of this lighting standard affect your long-term modeling results?

Answer. The IEA models estimate that the EISA regulations will result in a sharp rise in demand for CFLi from 2012 to 2015 peaking at just fewer than 900 million lamps. This is followed by a sharp down-turn in demand of about 560 million lamps in 2018. Thereafter, the second tier regulations take effect but only require a modest increase in sales because a large proportion of the screw-base lamp stock is already converted to higher efficiency lamps and the intermediate xenon halogen options that are now being replaced have a longer lifetime and slower replacement cycle than the GLS they replaced. Sales continue to rise more modestly but show ongoing fluctuations as the replacement lamp market responds to the 2015 peak and trough. In addition solid state lighting begins to make accelerated inroads into the lighting market in the 2020 to 2030 timeframe at the expense of CFLi (see: IEA (2010) Phaseout of Incandescent Lights, OECD/IEA).

We have not yet carried out a detailed energy impact analysis on these figures, however we assume that the replacement of GLS with CFLi's on a like-for-like basis would result in an electricity savings of 28% on average.

U.S. OIL DEMAND CURVE

Question 6. I found one of the most interesting trends across your collective forecasts is the flat, or even declining, demand for oil in developed countries, including the United States, over the next 25 years.

Mr. Burkhard's testimony notes that CERA believes aggregate oil demand in developed markets peaked in 2005 and will not exceed that level again.

The IEA predicts U.S. oil demand will drop by 10% by 2035.

The EIA reference case predicts that total liquid fuels consumption in the U.S. will increase 17%, to 22.0 million gallons per day, but almost all of that increase will come from biofuels. Oil demand appears essentially flat or falling.

All witnesses, if Congress and the Bush and Obama Administrations had failed to enact these policies, how likely is it that forecasted U.S. oil demand would be falling over the next 25 years?

All witnesses, if Congress and the Administration had failed to enact these policies, what would you anticipate would be the effect on global oil prices in 2035, compared with your reference case?

Answer. Progressive improvements in vehicle fuel efficiency, spurred by higher fuel costs as well as fuel-economy mandates (CAFE standards), and an expansion in biofuels production (Renewable Fuels Standard) contribute to the decline in US oil demand in the World Energy Outlook projections. In our Current Policies Scenario, US oil demand drops from 17.8 mb/d in 2009 to 16.1 mb/d by 2035. This takes account of recent changes to CAFE standards through 2016, in which cars must average fuel economy of 35.5 miles per gallon, and targets for biofuels production (that can substitute for use of oil products in transport). By 2035, our business-as-usual projections show US biofuels consumption rising to 1.21 mb/d, from 0.5 mb/d in 2009. The net change (+0.7 mb/d) in US biofuels consumption equates to roughly 40% of the drop in total oil demand during that time (1.7 mb/d). Without policies to promote vehicle efficiency and alternative fuels, the United States would undoubtedly see a higher level of oil demand and therefore some tightening of the global oil market, although our analysis in the World Energy Outlook does not specifically contain projections of such a scenario.

MEETING RENEWABLE FUELS TARGETS

Question 7. I am discouraged by EIA's prediction that the market will be unable to meet the targets set forth in RFS-2, which is the revised Renewable Fuels Standard that Congress passed in 2007.

That standard mandates production of thirty-six billion gallons of biofuels a year by the year 2022, sixteen billion gallons of which must be of "cellulosic" origin.

Your agency's analysis states that: "EIA's present view of the projected rates of technology development and market penetration of cellulosic biofuel technologies suggests that available quantities of cellulosic biofuels will be insufficient to meet the renewable fuels standard targets for cellulosic biofuels before 2022."

All witnesses, do you believe there will be enough flexible fuel vehicles available in America in 2022 to be able to consume biofuels production mandates in the RFS-2?

Answer. The IEA has not looked at this specific question in its scenarios. However, the vast majority of vehicles that will be on the road in 2022 are not yet on the road today, so can still be strongly influenced by policy. While it may require new incentives to reach the number of flex-fuel vehicles needed to match blending requirements in RFS-2, the cost of producing such vehicles is relatively low and there are no technical barriers to producing these in quite large volumes over the next 11 years.

IMPLICATIONS OF BUSINESS AS USUAL

Question 8. One thing I found lacking from most of the analyses was any kind of discussion of their broader implications. For example what kind of world will we live in 2035 if the forecasts contained in the reference cases prove accurate, a world that consumes 107 million barrels of oil per day.

Mr. Burkhard, in your testimony you describe a world in which access to energy services has allowed an unprecedented number of people to join the ranks of the middle class. Further reduction in global poverty is an outcome we can all celebrate.

But I appreciated Ambassador Jones' testimony as well, which devoted some attention to the risks of continuing on our present path. These include serious risks to national security, economic development, and of course the environment.

If I may quote from the Ambassador's written testimony:

. . . the global energy system, in which all countries are interdependent, faces a future that is increasingly untenable. To continue business-as-usual risks heightened insecurity, increasing economic volatility, and irreparable harm to the environment. We truly need a transformation in the world's energy system to a more secure, sustainable model.

I completely agree. Energy policy raises complex questions of equity and justice. I believe that too often, people who point to the unsustainable nature of our energy system are labeled as “anti-growth”. For all our sakes, I hope we can begin to move beyond such characterizations, and start talking about policy that can foster both growth and sustainability.

All Witnesses, would you please comment on the implications of continuing on our business-as-usual trajectory (i.e. the trajectory outlined in the EIA reference case)?

Answer. Continuing a business-as-usual trajectory leads to a future fraught with risk and unsustainable from an economic, security and environmental perspective. In our Current Policies Scenario, in which government policies are unchanged, we project world primary energy demand to rise by almost 50% over the next 25 years, underpinned by an unmitigated increase in global consumption of fossil-fuels (oil, gas and coal) led by emerging economies. The result is an energy mix that still remains heavily slanted toward fossil-fuels in 2035, and tighter energy markets characterized by higher prices and heightened volatility. Furthermore, continued dependence on fossil-fuels at levels in our Current Policies Scenario results in a global average temperature increase exceeding six degrees Celsius by 2100. At the same time, energy security risks on the supply side also increase. Suppliers of oil and gas become more concentrated, with the OPEC share of global oil supply rising toward half of the market by 2035. The level of investment to maintain existing supply and develop new ones is massive. There is a real risk that this spending will not fully come forward. National companies, which often have other demands placed on their financial resources and are not always market-oriented, are exercising greater control over development of indigenous supplies.

INVESTMENT LEVELS NEEDED IN NEXT HALF CENTURY

Question 9. The International Energy Agency has said that investment totaling \$45 trillion might be needed over the next half-century to prevent energy shortages and greenhouse gas emissions from undermining global economic growth. Is this analysis still up to date and accurate?

Answer. Analysis performed for the IEA publication Energy Technology Perspectives 2010 (ETP) shows that a transition to a low-carbon energy system would require the investment of USD 46 trillion additional to the investment required in the ETP’s Baseline scenario from 2010 to 2050. These additional investments are needed to achieve the global goal of halving energy related CO₂ emissions by 2050 compared to 2005 levels. Half of these additional investments are needed in the transport sector for advanced vehicle technologies. However, the transition to a low-carbon economy will result in significant energy security and economic benefits. For example, this additional investment would yield important fuel cost savings, due to efficiency improvements and as lower fuel demand drives down prices. Gross fuel-cost savings are estimated to be USD 112 trillion over this period. Subtracting these fuel savings from the additional investment costs yields net savings of USD 66 trillion. Even if both the investments and fuel savings over the period to 2050 are discounted back to their present values using a 10% discount rate, the net savings amount to USD 8 trillion.

HOW TO INCREASE ENERGY DIVERSITY

Question 10a. A common theme across all the witness testimony is that global energy demand is increasing and fossil fuel prices are likely to continue to increase. So it seems like if the U.S. continues to ignore this problem, the economic and security impacts will be significant. The witnesses also all seem to agree that diversifying America’s sources of energy is a key way to mitigate these harmful impacts.

What are the most economically efficient policies to increase U.S. energy diversity without the need for government to pick technology or special interest winners or losers?

Answer. Energy security is enhanced both by measures to diversify the energy mix and to reduce the intensity (and overall level) of energy use. Measures to promote energy efficiency represent the most economical opportunities for increasing US energy security. Significant opportunities exist in vehicles, buildings, appliances, lighting, industrial equipment and power generation technology.

Diversity, however, is also critical. Unfortunately, the US primary energy mix today remains heavily weighted toward fossil-fuels (37% oil, 24% coal, 24% gas). Nuclear accounts for only about 9.5% of primary energy demand. The shares of other sources are even less: biomass, under 4%; hydropower, less than 1%; and other renewable energy sources, less than 1%. In the Current Policies Scenario of the World Energy Outlook 2010, fossil fuels still dominate the mix in 2035, accounting for more than three-quarters of US primary energy demand. IEA recommendations that

would promote US energy diversity include: i) focus on decreasing fossil fuel dependence by pushing for strong energy efficiency and clean energy supply policies, ii) evaluate the costs and benefits of establishing a consistent CO₂ price, taking account of international experience in order to support market-pull measures for the accelerated introduction of clean energy technologies and iii) reinforce the development of open and competitive energy markets through consistent regulatory frameworks.

Question 10b. Do you agree with many energy experts who argue that a predictable price on carbon designed in a way that minimizes price volatility is the most economically efficiency and technology neutral way to realize greater energy efficiency and diversity?

Answer. Putting a price on carbon is a cornerstone policy in climate change response. It is inherently economically efficient because it captures a wider range of activities across the economy than a policy targeted only on a particular technology or narrow sector, and as such a lower-cost mix of measures should come forward to meet a given target. Also, It has the benefit of being technology neutral.

Carbon price volatility can be managed in many ways, which is important for investor confidence. In an emissions trading scheme, banking of allowances between years is a critical tool for participants to be able to manage changing conditions, and has been very successful in managing price volatility in the US SO₂ allowances program and in the European Emissions Trading System. Other proposed trading schemes introduce price caps and floors as a safety-valve against price excursions. These could be helpful if they are set at high enough levels, and if there is confidence in the market that they will not be altered. Finally a fixed carbon price (carbon tax) provides the most predictable investment climate, as long as there is investor confidence that the price is not subject to change with political cycles. However a fixed carbon price has the disadvantages that there is no guarantee on the level of emissions reductions that will be delivered, and it relies on the political will to set the tax at a high enough level, and willingness to increase it if emissions are higher than anticipated. Given the revolution in our energy systems needed to stay within the 2 degrees climate target agreed at Cancun, caps on emissions may be preferable to give certainty over delivery of emissions targets, and in this case price volatility is manageable with appropriate design choices (such as banking). However in the real world there is no one "right" policy mix: the most effective policy is that which maximises economic efficiency, within the constraints of political and public acceptability.

Moreover there are market barriers and imperfections that mean that a carbon price alone is not sufficient. In particular for energy efficiency, there is a huge reservoir of untapped potential for efficiency improvements that are already cost-effective at today's energy prices. The key to unlocking this potential is not so much to increase prices further, as it is to remove the non-economic barriers to energy efficiency's exploitation. These barriers include lack of information and split incentives (i.e. those manufacturing equipment or constructing buildings are usually not those who will use them), and policies need to be designed in light of real-world, rather than theoretical, consumer behaviour. Energy efficiency standards, labelling, and incentive schemes are all powerful tools in supplementing a carbon price to unlock this energy efficiency potential.

Question 10c. Are there links between policies to reduce greenhouse gas emissions and increasing energy diversity? If such policies are successful in significantly reducing world demand for fossil fuels, what impact on future prices is that likely to have?

Answer. In practice, many policies aimed at reducing GHG emissions from the energy sector will also have the effect of increasing energy diversity. Policies that promote the development and deployment of non-fossil fuel and renewable energy sources will lead to diversification away from fossil fuels. These can include renewables standards, feed-in tariffs, direct support to utilities to expand or develop non-fossil fuel energy sources, or the implementation of a carbon price (through a cap and trade system or through taxation). Policies designed to increase energy efficiency will not, per se, increase energy diversity, but can contribute to energy security as well as reducing GHG emissions.

The 450 Scenario of the IEA's World Energy Outlook 2010 assumes strong global action to reduce GHG emissions. In this scenario energy diversity is greatly increased by 2035 compared to 2008. In the US, in 2008, 49% of electricity generation came from coal, and 21% from gas, with just under 29% coming from non-fossil fuel sources. By contrast, in the 450 Scenario in 2035, these fossil fuels' combined contribution to electricity generation is projected to fall to just over 37%, with nuclear contributing just over one quarter, and various renewable technologies making up the remaining 37%, with none of these making up more than 14% of the total en-

ergy mix. The reduced demand for fossil fuels compared to a scenario with no additional policy to reduce GHGs is expected to lead to significantly lower prices. For instance, in the 450 Scenario, the oil price is expected to reach \$90 per barrel in 2009 dollars by 2035, as compared to \$135 per barrel in 2035 in the Current Policies Scenario, which assumes no policy change from mid-2010.

[Responses to the following questions were not received at the time the hearing went to press:]

QUESTIONS FOR JIM BURKHARD FROM SENATOR MURKOWSKI

Question 1. The need for oil exploration: About two years ago you said that “If oil demand does not begin to recover next year, the oil market could face a large surplus of production capacity for the next several years—even if growth in production capacity slows significantly.” This of course was when oil was barely above \$40 a barrel, and it’s obvious that demand has picked up enough and that OPEC has restricted enough output to more than double that price. My question is on investment in new reserves. Are enough exploratory operations underway to comfortably back up production for projected demand growth?

US ENERGY COMPANIES VERSUS NATIONAL OIL COMPANIES (NOCS)

Question 2. Can you describe how U.S. oil and gas producers operate with any disadvantages relative to National Oil Companies such as the OPEC owner companies?

OIL MARKETS

Question 3. If only about 3 percent of the world’s oil travels through the Suez canal and the SUMED pipeline, yet we are seeing some influence on the global commodity price resulting from instability around the Suez, does this indicate that seemingly small disruptions, real or potential, can have comparatively large impacts on global markets?

MAJOR OIL DISCOVERIES

Question 4. What was the impact on global investment and markets when the Tupi field was discovered off of Brazil in 2006, and how does the addition of a multi-billion barrel discovery impact the host nation and the industry?

CRISIS-DRIVEN ENERGY POLICY

Question 5. The Outer Continental Shelf Lands Act was implemented after the Arab oil embargo and subsequent price controls and economic shocks of the 1970’s, as was the authorization of the Trans-Alaska Pipeline System. Are these patterns of crisis and response as an unavoidable trend in U.S. energy policy?

a. Is the U.S., in your group’s view, more proactive or reactive in its energy policy?

CLEAN ENERGY STANDARD

Question 6. Should we learn a lesson from the Renewable Fuel Standard, which has fallen short of expectations, when considering an aggressive electricity mandate like the one the President is calling for? How likely is it that we will create unforeseen problems if we put a CES in place? To name just one example, will transmission problems and our inability to add significant amounts of renewable energy to the grid—become the new “blend wall”?

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Question 7. How substantial of an impact do you believe advanced biofuels, electric vehicles, and other technologies will have on petroleum consumption by 2020? By 2030?

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Question 8. If Congress had allowed the Coastal Plain of ANWR and other parts of Alaska to be opened to production, in 1 995 for example, we would be producing domestic oil at a considerably higher rate. What would that mean for our nation’s

energy security? Would we be more protected, or less protected, from civil unrest in Egypt, Jordan, and other parts of the Middle East? In the event of a supply disruption abroad, would we be better equipped, or less prepared, to deal with import shortages?

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Question 9. In a hypothetical scenario of September 2012., with unemployment is down to 8.0%, the economy growing at greater than 3.0% each quarter, and world markets on the upswing, where would you forecast the price of oil?

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Question 10. How does the amount of oil that could be taken offline by unrest in the Middle East compare to the amount of production that will be lost because of the absence of new exploratory permits in the Gulf of Mexico, and the absence of resumed exploratory operations?

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Question 11. Adam Sieminski, the Chief Energy Economist for Deutsche Bank, recently wrote that “We estimate that a [10 dollar] rise in the oil price subtracts approximately 0.5 percentage points off U.S. growth.” Do any of you agree with Mr. Sieminski’s assessment?

- a. Would this calculation change if the US supplied 60% of its own oil as opposed to importing 60% of its oil?

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Question 12. The head of the Bipartisan Policy Center noted earlier this week that “A one-dollar, one-day increase in a barrel of oil takes \$12 million out of the U.S. economy. If tensions in the Mideast cause oil prices to rise by \$5 for even just three months, over 5 billion dollars will leave the U.S. economy.” Do any of you disagree with that assessment?

IMPACT OF FEDERAL POLICIES

Question 13. What role does the federal government’s stimulus policies, and the Federal Reserve’s second round of quantitative easing, have played in boosting commodity prices? Have these policies boosted the price of oil, and, if so, by how much?

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Question 14. What role do you believe small modular nuclear reactors will have in meeting the global demand for electricity? What countries are moving forward with this technology and what countries are interesting in acquiring these reactors?

OIL SPILL REPORT

Question 15. Have you reviewed the recommendations made by the President’s Oil Spill Commission? Have you conducted any analysis on the impact those recommendations, if fully implemented, would have on domestic oil production, our import levels, and the global price of oil?

CHINA

Question 16. Can you shed light on what China’s energy picture really looks like, not just for renewable energy, but also its future demand for oil, natural gas, and coal?

QUESTIONS FOR JIM BURKHARD FROM SENATOR CANTWELL

EFFECT OF DOMESTIC DRILLING ON GAS PRICES AND FOREIGN OIL DEPENDENCE

Question 1. In response to the recent political unrest in the Middle East, and rising oil prices, we have heard familiar calls to expand domestic drilling in the United States—including offshore and in the pristine Arctic National Wildlife Refuge (ANWR)—typically with the claim that such actions will lower gasoline prices or reduce our dangerous over-reliance on foreign oil.

An Energy Information Administration (EIA) study from May 2008¹ projected the effects on oil prices of drilling in the Arctic National Wildlife Refuge. According to EIA's projections, in the most optimistic case, drilling in AN WR would reduce crude oil prices by approximately \$1.44 per barrel. I understand this would translate to approximately 3 to 4 cents per gallon of gasoline at the pump about 20 years from now.

It seems that EIA has found that drilling offshore would have a similarly negligible effect on prices. EIA issued an analysis in 2009 that examined the impact of maintaining the historical moratorium on drilling off the Atlantic, Pacific, and Eastern Gulf of Mexico. According to that analysis: "With limited access to the lower 48 OCS...there [would be] a small increase in world oil prices...The average price of imported low-sulfur crude...is \$1.34 per barrel higher, and the average U.S. price of gasoline is 3 cents per gallon higher."

Mr. Jones, Diwan, or Burkhard, would you please comment on your views on the ability of expanded domestic drilling to affect world oil prices?

IS OPEC ABLE TO OFFSET ANY INCREASED DOMESTIC DRILLING

Question 2. A number of experts have argued that any price impact of increased domestic production can be easily offset by OPEC. According to another EIA fact-sheet²:

One of the major factors on the supply side is OPEC, which can sometimes exert significant influence on prices by setting an upper production limit on its members, which produce about 40% of the world's crude oil. OPEC countries have essentially all of the world's spare oil production capacity, and possess about two-thirds of the world's estimated crude oil reserves.

Mr. Newell, Diwan, and Burkhard, is it true that OPEC, by modestly curtailing its output, has the power to offset any downward pressure that a marginal increase in US oil production might otherwise produce?

EFFECT OF SPECULATION ON OIL PRICES

Question 3. Several of the testified that oil price movements can be explained by supply and demand fundamentals, and these explain the upward pressure we've seen in recent months. We often hear about the lack of a "conclusive" smoking gun that links oil price spikes to speculation in the derivatives markets.

However, as you may know, the recently-passed Dodd-Frank Act requires the Commodities Future Trading Commission (CFTC) to establish rules to eliminate excessive position limits. Unfortunately, the 180-day deadline for those rules has passed and the regulatory process of establishing position limits is still in the early stages, and the limits are planned to be phased in over time.

Can the witnesses please comment on the likelihood of seeing a huge oil price spike this summer of the magnitude that we saw in the summer of 2008?

Do any of the witnesses believe that putting some limits on excessive speculation reduces the chances of rapid rise in oil prices similar to the summer of 2008?

EFFECT OF NEW PRODUCTION TECHNOLOGIES ON PRICES

Question 4. There seems to be some disagreement on whether investment in developing new production technologies ends up reducing the price of fossil fuels. We have heard a great deal about how oil and gas production is a capital intensive business that requires significant investment in new technologies to access new resources, whether those are unconventional resources, such as oil sands or shale, or hard to access resources, such as ultra-deepwater drilling.

Does investment in developing such hard-to-access resources result in lower fossil fuel prices? Or does it simply enable the production of harder to access and more expensive resources, thereby ensuring that oil and natural gas will only continue to flow as long as global prices remain high? Are you concerned that the U.S. is locking itself into dependence on a resource that is destined to get more and more expensive over time?

Do you believe there is now a new normal for fossil fuel prices? Just a decade ago OPEC had a \$22 to \$28 a barrel target range. In 2004, Ali Naimi, the Saudi oil minister called \$30 to \$34 a barrel a "fair and reasonable price" for oil. Why is the world now so willing to accept considerable higher level of fossil fuel prices?

¹ <http://www.eia.doe.gov/oiaf/servicert/anwr/results.html>

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U.S. OIL DEMAND CURVE

Question 6. I found one of the most interesting trends across your collective forecasts is the flat, or even declining, demand for oil in developed countries, including the United States, over the next 25 years.

Mr. Burkhard's testimony notes that CERA believes aggregate oil demand in developed markets peaked in 2005 and will not exceed that level again.

The IEA predicts U.S. oil demand will drop by 10% by 2035.

The EIA reference case predicts that total liquid fuels consumption in the U.S. will increase 17%, to 22.0 million gallons per day, but almost all of that increase will come from biofuels. Oil demand appears essentially flat or falling.

If Congress and the Bush and Obama Administrations had failed to enact these policies, how likely is it that forecasted U.S. oil demand would be falling over the next 25 years?

If Congress and the Administration had failed to enact these policies, what would you anticipate would be the effect on global oil prices in 2035, compared with your reference case?

MEETING RENEWABLE FUELS TARGETS

Question 7. I am discouraged by EIA's prediction that the market will be unable to meet the targets set forth in RFS2, which is the revised Renewable Fuels Standard that Congress passed in 2007.

That standard mandates production of thirty-six billion gallons of biofuels a year by the year 2022, sixteen billion gallons of which must be of "cellulosic" origin.

Your agency's analysis states that: -ETA's present view of the projected rates of technology development and market penetration of cellulosic biofuel technologies suggests that available quantities of cellulosic biofuels will be insufficient to meet the renewable fuels standard targets for cellulosic biofuels before 2022."

Do you believe there will be enough flexible fuel vehicles available in America in 2022 to be able to consume biofuels production mandates in the RFS-2?

IMPLICATIONS OF BUSINESS AS USUAL

Question 8. One thing I found lacking from most of the analyses was any kind of discussion of their broader implications. For example what kind of world will we live in 2035 if the forecasts contained in the reference cases prove accurate, a world that consumes 107 million barrels of oil per day.

Mr. Burkhard, in your testimony you describe a world in which access to energy services has allowed an unprecedented number of people to join the ranks of the middle class. Further reduction in global poverty is an outcome we can all celebrate.

But I appreciated Ambassador Jones' testimony as well, which devoted some attention to the risks of continuing on our present path. These include serious risks to national security, economic development, and of course the environment.

If I may quote from the Ambassador's written testimony:

...the global energy system, in which all countries are interdependent, faces a future that is increasingly untenable. To continue business-as-usual risks heightened insecurity, increasing economic volatility, and irreparable harm to the environment. We truly need a transformation in the world's energy system to a more secure, sustainable model..."

I completely agree. Energy policy raises complex questions of equity and justice. I believe that too often, people who point to the unsustainable nature of our energy system are labeled as "anti-growth". For all our sakes, I hope we can begin to move beyond such characterizations, and start talking about policy that can foster both growth and sustainability.

Would you please comment on the implications of continuing on our business-as-usual trajectory (i.e. the trajectory outlined in the EIA reference case)?

HOW TO INCREASE ENERGY DIVERSITY

Question 11. A common theme across all the witness testimony is that global energy demand is increasing and fossil fuel prices are likely to continue to increase. So it seems like if the U.S. continues to ignore this problem, the economic and security impacts will be significant. The witnesses also all seem to agree that diversifying America's sources of energy is a key way to mitigate these harmful impacts.

What are the most economically efficient policies to increase U.S. energy diversity without the need for government to pick technology or special interest winners or losers?

Do you agree with many energy experts who argue that a predictable price on carbon designed in a way that minimizes price volatility is the most economically efficiency and technology neutral way to realize greater energy efficiency and diversity?

Are there links between policies to reduce greenhouse gas emissions and increasing energy diversity? If such policies are successful in significantly reducing world demand for fossil fuels, what impact on future prices is that likely to have?

QUESTIONS FOR ROGER DIWAN FROM SENATOR MURKOWSKI

US ENERGY COMPANIES VERSUS NATIONAL OIL COMPANIES (NOCS)

Question 1. Can you describe how U.S. oil and gas producers operate with any disadvantages relative to National Oil Companies such as the OPEC owner companies?

OIL MARKETS

Question 2. If only about 3 percent of the world's oil travels through the Suez canal and the SUMED pipeline, yet we are seeing some influence on the global commodity price resulting from instability around the Suez, does this indicate that seemingly small disruptions, real or potential, can have comparatively large impacts on global markets?

MAJOR OIL DISCOVERIES

Question 3. What was the impact on global investment and markets when the Tupi field was discovered off of Brazil in 2006, and how does the addition of a multi-billion barrel discovery impact the host nation and the industry?

CRISIS-DRIVEN ENERGY POLICY

Question 4. The Outer Continental Shelf Lands Act was implemented after the Arab oil embargo and subsequent price controls and economic shocks of the 1970's, as was the authorization of the Trans-Alaska Pipeline System. Are these patterns of crisis and response as an unavoidable trend in U.S. energy policy?

a. Is the U.S., in your group's view, more proactive or reactive in its energy policy?

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Question 5. Should we learn a lesson from the Renewable Fuel Standard, which has fallen short of expectations, when considering an aggressive electricity mandate like the one the President is calling for? How likely is it that we will create unforeseen problems if we put a CES in place? To name just one example, will transmission problems and our inability to add significant amounts of renewable energy to the grid—become the new “blend wall”?

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