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2007 ANNUAL ENERGY OUTLOOK

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

TO

EXAMINE ENERGY INFORMATION ADMINISTRATION'S NEW ANNUAL ENERGY OUTLOOK

MARCH 1, 2007

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2007 ANNUAL ENERGY OUTLOOK

THURSDAY, MARCH 1, 2007

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

The committee met, pursuant to notice, at 9:32 a.m., in room SD–364, Dirksen Senate Office Building, Hon. Jeff Bingaman, chairman, presiding.

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

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

Thank you very much for joining us, Mr. Caruso. We appreciate your being here, and look forward to discussing the recently released Annual Energy Outlook.

I'd start the discussion by noting that the Energy Outlook is a forecast of U.S. energy prices and supply and demand through 2030, assuming current policies and current technology. As I understand it—and you can correct any of this that I misstate—but we can think of this forecast as a prediction of where we are going to wind up in 2030 if we do not change current energy policies.

The forecast predicts that energy-related carbon emissions will continue to increase by an average of 1.2 percent per year. This increase is higher than the average increase in total energy consumption due to an increased share of coal production. Carbon neutral energy consumption does not increase from 2005 levels in your forecast, as I read it. So without legislative action, according to the Energy Information Administration, the Energy Information Administration does not predict any use of carbon sequestration technology.

The forecast also predicts very slow growth in the use of biofuels. Only trace amounts of cellulosic ethanol are predicted by 2030. I think the figure is 240 million gallons per year by 2030. That's obviously far less than the 20 billion gallons of cellulosic ethanol that the President called for in his State of the Union Address. I think he was calling for that by 2017, instead of 2030.

I note that the forecast does not take into account the loan guarantee program that we authorized as part of EPAct. I hope the Department of Energy is moving as quickly as possible to make that guarantee program a useful tool for development of new technologies, and I trust that the realization of the program will reflect positively on EIA's outlook for cellulosic ethanol.

In the near term, I understand that EIA sees the potential for capacity of ethanol produced from corn to exceed demand. I'm not sure. I'll get back to that in the question rounds. I'm concerned that idle ethanol capacity in the near-term could do serious long-term harm to that industry.

Obviously, today's discussion is an opportunity for us to consider what changes in policy are appropriate as we move toward 2030, and we very much appreciate your being here.

Let me call on Senator Domenici for his comments.

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

Senator DOMENICI. Thank you, Senator Bingaman.

Mr. Caruso, your appearance has become somewhat of an event. And we think that you and your Department are continuing to do a better and better job of what you were charged to do. And I personally want to compliment you for the quality of what you're doing. It's very important that we have your Department, and somebody like you willing to stay at the helm and keep it going.

The Energy Outlook is the first that could fully consider the impacts of our 2005 Act. There are some success stories: for example, projected increases in the use of bio-fuels, increases in the appliance efficiencies, and breakthroughs in enhanced oil recovery.

However, the new Energy Outlook reminds us that passing a law isn't enough. We have to follow-up to make sure it's actually funded and implemented. The 2005 Energy Bill contained a number of requirements that will help us achieve energy security, but they aren't taken into account in the EIA's analysis. Part of the reason is justified, and part of it we could change by doing some things.

In some cases the EIA just decided that the impacts of R&D efforts are too speculative. A good example is cellulosic ethanol. While EIA finds the EPAct incentives will result in the first cellulosic production facilities being brought online, they also conclude that its use will not be widespread unless there are sufficient technological breakthroughs for ethanol, cellulosic ethanol, and other technologies, too numerous to list. EPAct provides for R&D programs that make those essential advances that we hope will bring new technologies to market.

While I understand the EIA's reluctance to try to predict the outcome of the cutting edge R&D programs, we must recognize the limitations of the forecast in this respect. Another more taunting aspect of the EPAct program that was not considered in the forecast because of lack of implementation, it will come as no surprise to those who attended the DOE budget hearing, that I am deeply disturbed by the lack of progress in EPAct's loan guarantee program. Senator Bingaman alluded to that.

In the 2007 Outlook, EIA finds that loan guarantees could substantially affect the economies of new power plants, lowering the costs of new, more efficient nuclear and wind plants by around 25 percent. A very big number—this is huge. But because of a lack of implementation by DOE, the impact of the loan guarantee program is not taken into account. As a result, while the EIA predicts the EPAct provisions will result in 12 gigawatts of new nuclear power capacity by 2030, the market share of nuclear will decline, as 90

percent of new power plants will burn coal and natural gas. I think that that forecast on nuclear is off the mark, even without the loan guarantee program. But, it is clear that the loan guarantee program could make a huge difference in our country's energy security, as well as the air we breathe.

For example, there is a company currently planning to build the world's first commercial cellulosic ethanol plant in Idaho. It needs a title XVII loan guarantee to make the financing work. These folks are business men; they can't wait forever. If the Department of Energy does not get on with implementing the title XVII loan guarantee, passed by Congress almost 19 months ago, this potential capital investment in cellulosic ethanol will almost certainly be deployed elsewhere. DOE's failure to expeditiously implement title XVII could mean the difference between creating a whole new cellulosic industry here in the U.S., and sending it all off to Europe.

Having said that, I believe that we don't need to sit here, and look at this outlook, and wring our hands. We know what to do, and in most cases we're ready to set up the necessary legal authorities in EPAct. Now all we have to do is to make it happen.

Thank you, Senator Bingaman, and I look forward to the testimony.

The CHAIRMAN. Thank you very much.

Let me just see if Senator Salazar had any opening statement, since he's the only other Senator here; we'll make a special opportunity for him if he had any statement before we hear from the witness.

Senator SALAZAR. I'll just include it at the time I ask questions.

The CHAIRMAN. Okay.

Senator SALAZAR. Thank you very much.

The CHAIRMAN. Okay, well we will proceed then.

And thank you very much for being here, Mr. Caruso. We look forward to hearing your testimony.

[The prepared statement of Senator Sanders follows:]

PREPARED STATEMENT OF HON. BERNARD SANDERS, U.S. SENATOR FROM VERMONT

Chairman Dorgan, Ranking Member Murkowski, thank you for convening this very vital hearing on one of the best ways to address the problems of global warming: energy efficiency.

Energy efficiency is so important. In fact, it is one of those win-win things: you reduce consumers' bills and you reduce the amount of global warming pollutants released to our atmosphere. So, why is it that we aren't funding the excellent energy efficiency programs that are already on the books, including weatherization? Additionally, when it comes to energy efficiency, we need to make sure that the federal government leads by example. One simple way to do this is to utilize energy performance contracts, which do not require any up-front capital from the agency. We also need to authorize additional energy efficiency programs, including some mentioned by the witnesses at today's hearing. I am particularly intrigued by the notion of allowing utilities to make a profit, perhaps even a greater profit than they would otherwise, by promoting energy efficiency over generation. I look forward to exploring this issue more.

I look forward to working with my colleagues and member of the community to determine the best ways to move forward because I know that we all share the desire to ensure a better energy future for our country so that good jobs and a good economy will peacefully co-exist with a healthy environment.

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

Mr. CARUSO. Thank you very much, Chairman Bingaman, Senators Domenici and Salazar, for giving us the opportunity to present the Energy Information Administration's latest long-term energy outlook, our Annual Energy Outlook 2007.

The reference case is from the outlook that we released on our website in December, and just last week we released the full report, which has more than two dozen alternative cases that address some of the issues that both Senators Bingaman and Domenici have mentioned in their opening statements.

I think it's accurate to think of the reference case in this outlook as the path we're on if we keep doing what we're doing—in terms of policy, in terms of the pace of technological change, the R&D that feeds into that, as well as the economic relationships in our economy between the use of energy and the production of energy.

I think, as Senator Bingaman had mentioned, one of the key assumptions here is that the policies in place as of October 2006, both at Federal, State, and local levels are projected to remain in place. Of course, we all recognize, and I can't emphasize enough, that future changes in energy and, particularly, environmental policies could have a significant impact on these projections. Some of the work we've done for Senator Salazar, Senator Bingaman, and others has shown impacts of changes in policies.

Let me start with one of the key assumptions, which is energy prices. All the prices I'll be referring to in this statement are adjusted for the effects of inflation, so they're in real terms at 2005 dollars. For oil, in the reference case, we're expecting oil prices to trend downward from their current levels. Just this week they're running about $61, $62 per barrel. We see that trending down to about $50 over the next 5 to 7 years, as new supplies come online, but then, in the middle part of the next decade, starting to increase again as a result of more difficulties in finding new oil and the higher costs to do so. In the long-run, our oil price assumption in real terms ranges between $50 and $60 per barrel for light sweet crude oil.

We recognize there's enormous uncertainty in that assumption, and therefore in the side cases we do—a range of a low-price case, which goes as low as $36 in real terms, to a high case of $100. Even that probably does not really encompass the full range at any given month or week. Prices could go above or below that over this 25-year time frame. So we do look at that in these side cases.

We also expect the average natural gas wellhead price to trend downward from current levels of a bit over $7 per thousand cubic feet, to just under $5 by the middle of next decade, as new import sources and increased domestic production do come on-stream. After 2015, we expect natural gas prices to increase to about $6 per thousand cubic feet in real terms.

For coal prices, we do not expect huge changes—although we do have a slightly higher expectation for coal prices than we did last year. The average price of coal over this 25-year timeframe ranges between about $1.10 per million Btus, to about $1.15. Again, meaning quite attractive with respect to base-load electric power use in this reference case.

Electricity prices follow the prices of natural gas and coal, initially falling but then slowly rising so that they're averaging about 8 cents per kilowatt hour over this timeframe. Eight-point-three cents in 2006, then dipping to 7.7 cents and back to 8.1 cents, are the actual numbers for electricity.

The key driver to this outlook is economic growth. We expect the U.S. economy to grow at just under 3 percent per year during this 25-year timeframe. That's slightly less than the 20-year track record for our economy between 1985 and 2005. The impact on consumption with that kind of economic growth, and the prices that I've mentioned, means that we're looking at about a 30 percent increase in total energy consumption in this country, between now and 2030. Going from 100 quadrillion Btu to about 130 quadrillion Btu.

The most rapid growth in energy demand will be in the commercial sector, and the second-most rapid growing sector will be transportation. As lower demand results from higher prices, we do have some increase in efficiency in all of the sectors as the use of more energy-efficient appliances continues to penetrate, partly as a result of the implementation of the provisions in EPAct 2005.

The U.S. economy also continues to become more energy efficient. Energy intensity measured as energy use per dollar of GDP—Gross Domestic Product—declines at an average rate of 1.8 percent per year through 2030, as shown in the written testimony in Figure 7. This is due to improved efficiency and shifts continuing in the economy to less energy-intensive goods and services.

Liquid fuels, mostly derived from petroleum but including biofuels, are expected to remain the primary fuels in the U.S., keeping a market share of just under 40 percent. The growth in liquid fuels is, of course, led by the transportation sector which uses 73 percent of all liquid fuels in 2030. Although improved efficiency moves ahead steadily, this can not offset the growth in travel that we expect in our economy over the next 20 to 25 years.

In 2030, the average fuel economy of new light-duty vehicles is projected to be 29.2 miles per gallon. That's 4 miles per gallon higher than 2005. Part of the improvement is due to recent standards for light trucks, and we expect steady increases in the sales of vehicles using unconventional technology, such as hybrids and turbo-charged diesels, as well as steady growth in flexible-fueled vehicles to be able to make use of alternatives fuels and the renewable bio-fuels.

Total demand for natural gas grows through 2020 then remains relatively flat. Between 2020 and 2030, rising natural gas prices cause it to lose market share to coal for electricity generation, but gas consumption in other sectors continues to increase. Under the no-change-in-policy assumption, coal remains the primary fuel for electricity generation, and its share of generation increases from 50 percent in 2005 to 57 percent in 2030. Total coal use is projected to increase from over 1,100 to nearly 1,800 million short-tons in 2030, with about 1,570 million short-tons being used for power generation and over 110 million short-tons in coal-to-liquids plants.

Total renewable energy is expected to increase from a 6 percent share of total energy consumption to nearly 8 percent in 2030, with the most rapid growth in non-hydro renewables.

Turning to fossil fuel supply, U.S. liquid fuels demand grows from about 21 million barrels a day to 27 million barrels per day, in 2030. At the same time, U.S. crude oil production increases from 5.7 million barrels per day in 2005 to 5.9 million barrels per day in 2015, as a result of deep-water off-shore production. But then the steady decline resumes, and domestic production falls to 5.4 million barrel per day by 2030.

The share of liquid fuels demand net-by-net imports decreases from 60.5 percent in 2005 to 54 percent in 2009, then increases to 61 percent in 2030.

In the alternative prices cases, U.S. crude production ranges from 5.3 to 6.0 million barrels per day, and the net import share of consumption ranges from 49 percent in the high price case to 67 percent in the low price case.

The total petroleum supply includes a significant amount of coal-to-liquids in this scenario—in the reference case, over 400,000 barrels a day, and in the high- price case, it includes 1.7 million barrels per day of liquids from coal.

U.S. natural gas production is projected to increase to 20.8 trillion cubic feet in 2020, before declining slightly in 2030. The production of unconventional natural gas is expected to be a significant source of domestic supply, increasing to about a 50 percent share of total production in 2030.

The pipeline to bring the gas from Alaska's North Slope to the Lower 48, is projected to commence operation before 2020, allowing Alaskan production to increase from 0.5 trillion cubic feet in 2005, to 2.2 trillion cubic feet in 2021. Net pipeline imports are expected to decline from 3 trillion cubic feet in 2005, to less than 1 trillion cubic feet by 2030—due to both accelerating decline rates in older fields in Canada, and growing domestic demand in Canada. Therefore, to meet growing demand, LNG imports are expected to increase from 0.6 trillion cubic feet in 2005, to 4.5 trillion cubic feet in 2030.

Of the fossil fuels, coal has the most rapid growth production, as shown in Figure 12 in the written testimony.

Turning to ethanol and other bio-fuels, we project a significant steady rise in the production of ethanol to reach 14.6 billion gallons of ethanol consumption in 2030, about 20 percent higher than we were projecting last year. Most of this is expected to be from corn-based sources, based on current technology, and current economics and current policy. These projections do not reflect the effect of new policy proposals, such as the President's plan to displace 20 percent of gasoline consumption of the next 10 years through a combination of higher CAFE standards and increased use of renewable and alternative fuels.

Electricity consumption, including onsite generation, is expected to increase from 3,800 to 5,500 billion kilowatt hours during the 25-year timeframe. This is a slightly lower rate of growth than we expected last year, in last year's outlook, due to the use of more efficient appliances. To meet growing demand, total electricity generation increases by 44 percent between 2005 and 2030, with coal supplying about 75 percent of the increase.

About 292 gigawatts of new generation capacity is expected, and coal is expected to account for about 54 percent. In the latter part

of the projection, natural gas will lose market share to coal due to rising prices, declining from 19 percent to 16 percent of the generation market.

Renewable generation will increase, in part, due to EPAct 2005 and various State programs, but will remain at about 9 percent of total generation. While hydro-power continues to dominate renewable generation, significant increases are expected for both biomass and wind.

Nuclear capacity is expected to increase from 100 to 113 gigawatts by 2030. This includes 12.5 gigawatts of capacity of new plants, and 3 gigawatts of upgrades of existing plants, offset somewhat by 2.6 gigawatts of retiring capacity.

Energy-related carbon dioxide emissions account for about 80 percent of total U.S. greenhouse gas emissions. CO_2 emissions from the use of energy are expected to increase by about one-third between 2005 and 2030. This is slightly faster than the rate of increase of energy consumption, due to the increasing reliance on coal in this reference case.

To wrap up, Mr. Chairman, our projections include significant improvements in technology cost and performance over time. However, the pace of these improvements may be understated or overstated, since the rate at which the characteristics of energy-using and -producing technologies will change is highly uncertain. Therefore, we do include a number of sensitivity cases, as I mentioned, in the latest outlook, including a high-technology case which assumes earlier availability, lower costs, and high efficiencies for end-use technologies in all of the sectors.

A slow-technology case assumes these characteristics are frozen at the 2006 level, and that side case is also in there.

Generally, the difference between our high-and low- technology cases grows over the forecast horizon, reflecting the greater opportunity for advanced technologies to enter the market as the Nation's capital stock is replaced and expanded over time.

Mr. Chairman, this concludes the summary of our latest long-term outlook and I would be pleased to attempt to answer questions you and other members of the committee may have at this time.

Thank you.

[The prepared statement of Mr. Caruso follows:]

PREPARED STATEMENT OF GUY CARUSO, 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 long-term outlook for energy markets in the United States.

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

The Annual Energy Outlook (AEO) provides projections and analysis of domestic energy consumption, supply, prices, and energy-related carbon dioxide emissions through 2030. The Annual Energy Outlook 2007 (AEO2007) is generally based on Federal and State laws and regulations in effect on or before October 31, 2006. (An exception to this approach is that the ethanol tax credit is assumed to continue beyond its scheduled expiration in 2010 in the AEO2007 reference case.) The potential impacts of pending or proposed legislation, regulations, and standards—or of sections of legislation that have been enacted but that require funds or implementing regulations that have not been provided or specified—are not reflected in the projections.

The AEO2007 includes consideration of the impact of the Energy Policy Act of 2005 (EPAct 2005), signed into law August 8, 2005. Consistent with the general approach adopted in the AEO, the reference case does not consider those sections of EPAct 2005 that require appropriations for implementation or sections with highly uncertain impacts on energy markets. For example, EIA does not try to anticipate the policy response to the many studies required by EPAct 2005 or the impacts of the research and development funding authorizations included in the law. The AEO2007 reference case only includes those sections of EPAct 2005 that establish specific tax credits, incentives, or standards—about 30 of the roughly 500 sections in the legislation.

The AEO2007 is not meant to be an exact prediction of the future but represents a likely energy future, given technological and demographic trends, current laws and regulations, and consumer behavior as derived from known data. EIA recognizes that projections of energy markets are highly uncertain and subject to many random events that cannot be foreseen such as weather, political disruptions, and technological breakthroughs. In addition to these phenomena, long-term trends in technology development, demographics, economic growth, and energy resources may evolve along a different path than expected in the projections. The complete AEO2007, which EIA released last week, includes a large number of alternative cases intended to examine these uncertainties. The following discussion summarizes the highlights from the AEO2007 reference case for the major categories of U.S. energy prices, demand, and supply and also includes the results of some alternative cases.

THE U.S. ENERGY OUTLOOK

Energy Prices

The long-term outlook on energy prices in the AEO2007 reference case (Figure 1)* is similar to that in last year's AEO. World crude oil prices, expressed in terms of the average price of imported low-sulfur, light crude oil to U.S. refiners, are projected to fall from 2006 levels to about $50 per barrel in (2005 dollars) in 2014, then rise to $59 per barrel in 2030. In nominal dollars, the projected price is about $95 in 2030.

Geopolitical trends, the adequacy of investment and the availability of crude oil resources and the degree of access to them, are all inherently uncertain. To evaluate the implications of uncertainty about world crude oil prices, the AEO2007 includes two other price cases, a high price case and a low price case, based on alternative paths of investment in production capacity in key resource rich regions, access restrictions, and an assessment of the Organization of Petroleum Exporting Countries' (OPEC) ability to influence prices during period of volatility (Figure 2). The cases are designed to address the uncertainty about the market behavior of OPEC. Although the price cases reflect alternative long-term trends, they are not designed to reflect short-term, year-to-year volatility in world oil markets, nor are they intended to span the full range of possible outcomes. In the low price case, world crude oil prices are projected to gradually decline from 2006 levels to $34 per barrel (2005 dollars) in 2016 and remain relatively stable in real dollar terms thereafter, rising only slightly to $36 per barrel in 2030. In the high price case, oil prices dips somewhat from 2006 levels, then increase steadily to $100 per barrel (2005 dollars) in 2030.

In the AEO2007 reference case, average wellhead prices for natural gas in the United States decline gradually from current levels, as increased drilling brings on new supplies and new import sources become available. The average price falls to just under $5 per thousand cubic feet in 2015 (2005 dollars), then rises gradually to about $6 per thousand cubic feet in 2030 (equivalent to $9.63 per thousand cubic feet in nominal dollars). Growth in liquefied natural gas (LNG) imports, Alaskan production, and lower-48 production from unconventional sources are not expected

* Figures 1 through 14 have been retained in committee files.

to increase sufficiently to offset the impacts of resource depletion and increased demand in the lower-48 States. Projections of wellhead prices in the low and high price cases reflect alternative assumptions about the cost and availability of natural gas, including imports of LNG.

In the AEO2007 reference case, average real minemouth coal prices (in 2005 dollars) are expected to fall from $1.15 per million Btu ($23.34 per short ton) in 2005 to $1.08 per million Btu ($21.51 per short ton) in 2019, as prices moderate following a rapid run-up over the past few years. After 2019, new coal-fired power plants are expected to increase total coal demand, and prices are projected to rise to $1.15 per million Btu ($22.60 per short ton) in 2030. Without adjustment for inflation, the average minemouth price of coal in the AEO2007 reference case rises to $1.85 per million Btu ($36.38 per ton) in 2030.

Electricity prices follow the prices of fuels to power plants in the reference case, falling initially as fuel prices retreat after the rapid increases of recent years and then rising slowly. From a peak of 8.3 cents per kilowatthour (2005 dollars) in 2006, average delivered electricity prices decline to a low of 7.7 cents per kilowatthour in 2015 and then increase to 8.1 cents per kilowatthour in 2030.

Energy Consumption

Total energy consumption is projected to grow by about 31 percent between 2005 and 2030, at a rate of 1.1 percent per year or less than one-half the rate of growth in gross domestic product (GDP) (2.9 percent per year), as energy use per dollar of GDP continues to improve. Fossil fuels account for about 85 percent of the total growth. The increase in coal use occurs mostly in the electric power sector, where strong growth in electricity demand and favorable economics under current environmental policies prompt coal-fired capacity additions. About 61 percent of the projected increase in coal consumption occurs after 2020, when higher natural gas prices make coal the fuel of choice for most new power plants. Transportation accounts for 94 percent of the projected increase in liquids consumption, dominated by growth in fuel use for light-duty vehicles. The remainder of the liquids growth in the AEO2007 reference cases occurs in the industrial sector, primarily in refineries. Industry and buildings account for about 90 percent of the increase in natural gas consumption from 2005 to 2030.

Transportation energy demand is expected to increase from 28.1 quadrillion British thermal units (Btu) in 2005 to 39.3 quadrillion Btu in 2030, an average growth rate of 1.4 percent per year (Figure 3). Most of the growth in demand between 2005 and 2030 occurs in light-duty vehicles (56 percent of total growth), followed by heavy truck travel (23 percent of growth) and air travel (11 percent of growth). Delivered industrial energy consumption reaches 30.5 quadrillion Btu in the AEO2007 reference case in 2030, growing at an average rate of 0.8 percent per year between 2005 and 2030, as efficiency improvements in the use of energy only partially offset the impact of growth in manufacturing output. Delivered commercial sector energy consumption is projected to grow at a more rapid average annual rate of 1.6 percent between 2005 and 2030, reaching 12.4 quadrillion Btu in 2030, consistent with growth in commercial floorspace. The most rapid increase in commercial energy demand is projected for electricity used for office equipment, computers, telecommunications, and miscellaneous small appliances. Delivered residential energy consumption is projected to grow from 11.6 quadrillion Btu in 2005 to 13.8 quadrillion Btu in 2030, an average rate of 0.7 percent per year. This growth is consistent with population growth and household formation. The most rapid growth in residential energy demand is projected to be in the demand for electricity used to power computers, electronic equipment, and small appliances.

While the EIA reference case incorporates significant improvements in technology cost and performance over time, it may either overstate or understate the actual future pace of improvement since the rate at which the characteristics of energy-using and producing technologies will change is highly uncertain. EIA does not attempt to estimate how increased government spending might specifically impact technology development. However, to illustrate the importance of future technology characteristics, EIA does develop sensitivity cases with alternative technology assumptions. Relative to the reference case, EIA' s high technology cases generally assume earlier availability, lower costs, and higher efficiencies for end-use technologies and new fossil-fired, nuclear, and nonhydroelectric renewable generating technologies. Using high technology assumptions in place of the reference case technology assumptions results in lower projected levels of energy use and energy-related carbon dioxide emissions through 2030 (Figure 4) . Generally, the difference between the projections for the two cases grows over the projection horizon, reflecting the greater opportunity for advanced technologies to enter the market as the

Nation's energy-producing and -consuming capital stock is replaced and expanded over time.

The reference case includes the effects of several policies aimed at increasing energy efficiency in both end-use technologies and supply technologies, including minimum efficiency standards and voluntary energy savings programs. However, the impact of efficiency improvement on energy consumption could differ from what is shown in the reference case, as illustrated in Figure 5 which compares energy consumption in three cases. The 2006 technology case assumes no improvement in the efficiency of available equipment beyond that available in 2005. By 2030, 6.5 percent more energy (8.6 quadrillion Btu) is required than in the reference case. The high technology case assumes that the most energy-efficient technologies are available earlier with lower costs and higher efficiencies. By 2030, total energy consumption is 8.8 quadrillion Btu, or 6.7 percent, lower in the high technology case when compared with the reference case.

Total consumption of liquid fuels and other petroleum products is projected to grow at an average annual rate of 1.1 percent in the AEO2007 reference case, from 20.7 million barrels per day in 2005 to 26.9 million barrels per day in 2030 (Figure 6) led by growth in transportation uses, which account for 67 percent of total liquid fuels demand in 2005, increasing to 73 percent in 2030. Improvements in the efficiency of vehicles, planes, and ships are more than offset by growth in travel. In the low and high price cases, petroleum demand in 2030 ranges from 28.8 to 24.6 million barrels per day, respectively.

The AEO2007 reference case reflects the new fuel economy standards for light trucks finalized by the National Highway Transportation Safety Administration in March 2006 that are based on vehicle footprint and the product mix offered by manufacturers. The new Corporate Average Fuel Economy (CAFE) standard, coupled with technological advances, is expected to have a positive impact on the fuel economy of new light-duty vehicles. Market-driven increases in the sales of alternative vehicle technologies, such as flex-fuel, hybrid, and diesel vehicles, will also have an impact. In the reference case, average fuel economy for new light-duty vehicles is projected to increase to 29.2 miles per gallon in 2030, or 4 miles per gallon higher then the current average.

Additional improvement is projected in the high technology and high price cases, as a result of consumer demand for more fuel-efficient cars and improved economics that make producing them more profitable. In the 2006 technology and low oil price cases, the projections for light-duty vehicle fuel economy in 2030 are lower than those in the reference case, but they still are higher than the 2005 CAFE standard for cars and the 2011 CAFE standard for light trucks. In the low price case, fuel economy for new light-duty vehicles in 2030 is 3.3 percent lower than projected in the reference case—due to consumer preference for more powerful vehicles over fuel economy—and in the 2006 technology case it is 7 percent lower than in the reference case.

Total consumption of natural gas is projected to increase from 22.0 trillion cubic feet in 2005 to 26.1 trillion cubic feet in 2030, but there is virtually no growth over the last decade. Growth in natural gas consumption between 2020 and 2030 in the residential, commercial, and industrial sectors is offset by a decline in natural gas consumption for electric power generation. Natural gas is expected to lose market share to coal in the electric power sector as result of continued increases in natural gas prices in the latter half of the projection. Natural gas use in the power sector is projected to decline by 18 percent between 2020 and 2030.

Total coal consumption is projected to increase from 22.9 quadrillion Btu (1,128 million short tons) in 2005 to 34.1 quadrillion Btu (1,772 million short tons) in 2030, growing by 1.6 percent per year. About 92 percent of the coal is currently used for electricity generation. Coal remains the primary fuel for electricity generation and its share of generation (including end-use sector generation) is expected to increase from about 50 percent in 2005 to 57 percent in 2030. Total coal consumption in the electric power sector is projected to increase by an average of 1.6 percent per year, from 20.7 quadrillion Btu in 2005 to 31.1 quadrillion Btu in 2030. Another fast growing market for coal is expected in coal-to-liquids (CTL) plants. These plants convert coal to synthetic gas and create clean diesel fuel, while producing surplus electricity as a by-product. In the reference case, coal use in CTL plants is projected to reach 1.8 quadrillion Btu by 2030, or 5 percent of the total coal use. In the high price case, coal used in CTL plants is projected to reach 6.9 quadrillion Btu. In the low price case, however, the plants are not expected to be economical within the 2030 time frame.

Total electricity consumption, including both purchases from electric power producers and on-site generation, is projected to grow from 3,821 billion kilowatt hours in 2005 to 5,478 billion kilowatt hours in 2030, increasing at an average rate of 1.5

percent per year. The most rapid growth (2.0 percent per year) occurs in the commercial sector, as building floorspace is expanded to accommodate growing service industries. Growing use of electricity for computers, office equipment, and small electrical appliances is partially offset in the AEO2007 reference case by improved efficiency.

Total marketed renewable fuel consumption (including ethanol for gasoline blending, of which 1.2 quadrillion Btu in 2030 is included with liquid fuels consumption) is projected to grow by 1.9 percent per year in the reference case, from 6.2 quadrillion Btu in 2005 to 9.9 quadrillion Btu in 2030, largely as a result of State mandates for renewable electricity generation and the effect of production tax credits. About 52 percent of the projected demand for renewables in 2030 is for grid-related electricity generation (including combined heat and power), and the rest is for dispersed heating and cooling, industrial uses, and fuel blending.

Ethanol use grows in the AEO2007 reference case from 4 billion gallons in 2005 to 14.6 billion gallons in 2030 (about 8 percent of total gasoline consumption by volume). Ethanol use for gasoline blending grows to 14.4 billion gallons and E85 consumption to 0.2 billion gallons in 2030. The ethanol supply is expected to be produced from both corn and cellulose feedstocks, both of which are supported by ethanol tax credits included in EPAct 2005, but domestically-grown corn is expected to be the primary source, accounting for 13.6 billion gallons of ethanol production in 2030.

Energy Intensity

Energy intensity, as measured by primary energy use per dollar of GDP (2000 dollars), is projected to decline at an average annual rate of 1.8 percent from 2005 to 2030. Although energy use generally increases as the economy grows, continuing improvement in the energy efficiency of the U.S. economy and a shift to less energy-intensive activities are projected to keep the rate of energy consumption growth lower than the GDP growth rate (Figure 7). The projected rate of energy intensity decline in the AEO2007 approximately matches the decline rate between 1992 and 2005 (1.9 percent per year). Energy-intensive industries' share of overall industrial shipments is projected to fall at an average rate of 0.6 percent per year, a slower decline rate than the 1.2 percent per year experienced from 1992 to 2005.

Historically, energy use per person has varied over time with the level of economic growth, weather conditions, and energy prices, among many other factors. During the late 1970s and early 1980s, energy consumption per capita fell in response to high energy prices and weak economic growth. Starting in the late 1980s and lasting through the mid-1990s, energy consumption per capita increased with declining energy prices and strong economic growth. Per capita energy use is projected to increase by an average of 0.3 percent per year between 2005 and 2030 in the AEO2007 reference case, with relatively high energy prices moderating the demand for energy services and promoting interest in efficiency improvements in buildings, transportation, and electricity generation.

Energy Production and Imports

Total energy consumption is expected to increase more rapidly than domestic energy supply through 2030. As a result, net imports of energy on a Btu basis are projected to meet a growing share of energy demand.

Liquids and Other Petroleum Products.—AEO2007 includes a reorganized breakdown of fuel categories that reflects the increasing importance of conversion technologies that can produce liquid fuels from natural gas, coal, and biomass. In the past, petroleum production, net imports of petroleum, and refinery gain could be balanced against the supply of liquid fuels and other petroleum products. Now, with other primary energy sources being used to produce significant amounts of liquid fuels, those inputs must be added in order to balance production and supply. Conversely, the use of coal, biomass, and natural gas for liquid fuels production must be accounted for in order to balance net supply against net consumption for each primary fuel. In AEO2007, the conversion of nonpetroleum primary fuels to liquid fuels is explicitly modeled, along with petroleum refining, as part of a broadly-defined refining activity that is included in the industrial sector. AEO2007 specifically accounts for conversion losses and co-product outputs in the broadly defined refining activity.

Projected U.S. crude oil production increases from 5.2 million barrels per day in 2005 to a peak of 5.9 million barrels per day in 2017 as a result of increased production offshore, predominantly in the deep waters of the Gulf of Mexico. Production is subsequently projected to fall to 5.4 million barrels per day in 2030. Total domestic liquids production (crude oil, natural gas plant liquids, refinery processing gains, coal-to-liquids, gas-to-liquids, ethanol, blending components, and biodiesel), in-

creases from 8.3 million barrels per day in 2005 to a peak of 10.5 million barrels per day in 2022 and then remains at about that level through 2030.

Net liquids imports, including both crude oil and refined products, drops from 60 percent of total liquids supply in 2005 to 54 percent in 2009, before increasing to 61 percent in 2030 (Figure 8). Under alternative oil price projections, the 2030 import fraction ranges from 67 in the low price case to 49 percent in the high price case. Figure 9 compares the impact of the AEO2007 reference, high price, and low price cases on U.S. liquids production, consumption, and imports.

In the U.S. energy markets, the transportation sector consumes about two-thirds of all liquid petroleum products and the industrial sector about one-quarter. The remaining 10 percent is divided among the residential, commercial, and electric power sectors. With limited opportunities for fuel switching in the transportation and industrial sectors, large price-induced changes in U.S. liquid petroleum consumption are unlikely, unless changes in petroleum prices are very large or there are significant changes in the efficiencies of liquid petroleum-using equipment.

Higher crude oil prices spur greater exploration and development of domestic oil supplies, reduce demand for petroleum, and slow the growth of oil imports in the high price case compared to the reference case. Total domestic liquid petroleum supply in 2030 is projected to be 2.0 million barrels per day (19 percent) higher in the high price case than in the reference case. Production in the high case includes 1.7 million barrels per day in 2030 of synthetic petroleum fuel produced from coal and natural gas, compared to 0.4 million barrels per day in the reference case (Figure 10). Total net imports in 2030, including crude oil and refined products, are reduced from 16.4 million barrels per day in the reference case to 12.0 million barrels per day in the high price case.

Natural Gas.—Total domestic natural gas production, including supplemental natural gas supplies, increases from 18.3 trillion cubic feet in 2005 to 21.1 trillion cubic feet in 2022, before declining to 20.6 trillion cubic feet in 2030 in the AEO2007 reference case (Figure 11). Lower-48 offshore production is projected to grow from 3.4 trillion cubic feet in 2005 to a peak of 4.6 trillion cubic feet in 2015 as new resources come online in the Gulf of Mexico. After 2015, lower-48 offshore production declines to 3.3 trillion cubic feet in 2030, as investment is inadequate to maintain production levels.

Lower-48 production of unconventional natural gas is expected to be a major contributor to growth in U.S. natural gas supplies. In the AEO2007 reference case, unconventional natural gas production is projected to account for 50 percent of domestic U.S. natural gas production in 2030. Unconventional natural gas production is projected to grow from 8.0 trillion cubic feet in 2005 to 10.2 trillion cubic feet in 2030. With completion of an Alaskan natural gas pipeline in 2018, total Alaskan production is projected to increase from 0.5 trillion cubic feet in 2005 to 2.2 trillion cubic feet in 2021 and to remain at about that level through 2030.

Overall reliance on domestic natural gas supply to meet demand is projected to fall from 83 percent in 2005 to 79 percent in 2030. The growing dependence on imports in the United States occurs despite efficiency improvements in both the consumption and the production of natural gas.

Net pipeline imports are expected to decline from 2005 levels of about 3.0 trillion cubic feet to about 0.9 trillion cubic feet by 2030 due to resource depletion in Alberta, growing domestic demand in Canada, and a downward reassessment of the potential for unconventional natural gas production from coal seams and tight formations in Canada. To meet a projected U.S. demand increase of 4.1 trillion cubic feet from 2005 to 2030 and to offset an estimated 2.1 trillion cubic feet reduction in pipeline imports, the United States is expected to depend increasingly on imports of LNG. LNG imports in the AEO2007 reference case are projected to increase from 0.6 trillion cubic feet in 2005 to 4.5 trillion cubic feet in 2030.

One area of uncertainty examined through sensitivity cases considers the rate of technological progress and its affect on future natural gas supply and prices. Technological progress affects natural gas production by reducing production costs and expanding the economically recoverable natural gas resource base. In the slow oil and gas technology case, advances in exploration and production technologies are assumed to be 50 percent slower than those assumed in the reference case, which are based on historical rates. As a result, domestic natural gas development costs are higher, production is lower, wellhead prices are higher at $6.32 per thousand cubic feet in 2030 (compared to $5.98 in the reference case) (2005 dollars), natural gas consumption is reduced, and LNG imports are higher than in the reference case. In 2030, natural gas production is 18.7 trillion cubic feet (9 percent lower than in the reference case), net natural gas imports are 6.4 trillion cubic feet (18 percent higher), and domestic natural gas consumption is 25.1 trillion cubic feet (3 percent lower). Conversely, the rapid technology case assumes 50 percent faster improve-

ment in technology. In that case, natural gas production in 2030 is 23.5 trillion cubic feet (14 percent higher than in the reference case), net natural gas imports are 4.3 trillion cubic feet (21 percent lower), domestic natural gas consumption is 27.9 trillion cubic feet (7 percent higher), and the average wellhead price is $5.21 per thousand cubic feet.

Coal.—As domestic coal demand grows in the AEO2007 reference case, U.S. coal production is projected to increase at an average rate of 1.6 percent per year, from 1,131 million short tons (23.2 quadrillion Btu) in 2005 to 1,691 million short tons (33.5 quadrillion Btu) in 2030. Production from mines west of the Mississippi River is expected to provide the largest share of the incremental coal production and grows at an average rate of 2.4 percent per year, versus 0.4 percent per year for mines east of the Mississippi River. In 2030, almost 68 of domestic coal production is projected to originate from States west of the Mississippi (Figure 12).

Electricity Generation

In the AEO2007 reference case, total electricity generation, including generation by electricity producers and on-site, increases by 44 percent between 2005 and 2030, growing at an average rate of 1.5 percent per year. Coal is projected to supply about 75 percent of the increase in electricity generation from 2005 to 2030. Generation from coal is projected to grow from about 2,015 billion kilowatthours in 2005 to 3,330 billion kilowatt hours in 2030 in the reference case. In 2030, coal is projected to meet 57 percent of generation, up from 50 percent in 2005 (Figure 13). Between 2005 and 2030, AEO2007 projects that 156 gigawatts of new coal-fired generating capacity will be constructed, including 11 gigawatts at coal-to-liquids plants and 67 gigawatts of integrated gasification combined-cycle plants. Given the assumed continuation of current energy and environmental policies in the reference case, carbon capture and sequestration technology is not projected to come into use during the projection period.

Generation from natural gas is projected to increase from 752 billion killowatt hours in 2005 to 1,061 billion killowatt hours in 2020, as recently-built plants are used more intensively to meet growing demand. After 2020, however, generation from new coal and nuclear plants is expected to displace some natural-gas-fired generation. Total natural-gas-fired generation declines by 12 percent after 2020 to 937 billion kilowatt hours in 2030 and the natural gas share of electricity generation is projected to decline from 19 percent in 2005 to 16 percent in 2030.

Nuclear generating capacity in the AEO2007 reference case is projected to increase from 100 gigawatts in 2005 to 112.6 gigawatts in 2030. The increase includes 12.5 gigawatts of capacity at newly built nuclear power plants and 3 gigawatts expected from uprates of existing plants, offset by 2.6 gigawatts of retirements. The 12.5 gigawatts of newly built capacity includes 9 gigawatts of new nuclear capacity built in response to the EPAct 2005 production tax credits (reflecting a prorated share of the credits as outlined in the 2006 Internal Revenue Service ruling) and 3.5 additional gigawatts of capacity built without credits. AEO2007 also reflects the change in the Production Tax Credit (PTC) for new nuclear power plants that was included in the Gulf Opportunity Zone Act of 2005 (P.L. 109-135), eliminating the indexing provision in the value of the credit that had been provided in EPAct 2005.

Total electricity generation from nuclear power plants is projected to grow from 780 billion kilowatthours in 2005, 19 percent of total generation, to 896 billion kilowatt hours in 2030 in the AEO2007 reference case, accounting for about 15 percent of total generation in 2030. Additional nuclear capacity is projected in some of the alternative AEO2007 cases, particularly those that project higher demand for electricity or even higher fossil fuel prices.

The use of renewable technologies for electricity generation is projected to grow, stimulated by improved technology, higher fossil fuel prices, and extended tax credits in EPAct 2005 and in State renewable energy programs (renewable portfolio standards, mandates, and goals). The expected impacts of State renewable portfolio standards, which specify a minimum share of generation or sales from renewable sources, are included in the projections. The AEO2007 reference case includes the extension and expansion of the PTC for renewable generation through December 31, 2007, as enacted in EPAct 2005, but not the subsequent extension through the end of 2008 that was enacted in December 2006. Total renewable generation in the AEO2007 reference case, including hydroelectric power and renewables-fueled combined heat and power generation, is projected to grow by 1.5 percent per year, from 357 billion kilowatt hours in 2005 to 519 billion kilowatt hours in 2030. The renewable share of electricity generation is projected to remain at about 9 percent of total generation from 2005 to 2030.

Energy-Related Carbon Dioxide Emissions

Absent the application of carbon capture and sequestration technology, which is not expected to come into widespread use without a decrease in the cost of capture and changes in current policies that are not included in the reference case, carbon dioxide emissions from the combustion of fossil fuels are proportional to fuel consumption and carbon content, with coal having the highest carbon content, natural gas the lowest, and petroleum in between.

Carbon dioxide emissions from energy use are projected to increase from 5,945 million metric tons in 2005 to 7,950 million metric tons in 2030 in the AEO2007, an average annual increase of 1.2 percent (Figure 14). The energy-related carbon dioxide emissions intensity of the U.S. economy is projected to fall from 538 metric tons per million dollars of GDP in 2005 to 353 metric tons per million dollars of GDP in 2030, an average decline of 1.7 percent per year. Projected increases in carbon dioxide emissions primarily result from a continued reliance on coal for electricity generation and on petroleum fuels in the transportation sector.

CONCLUSION

As I noted at the outset, EIA does not take positions on policy issues, but we do produce data, analyses, and projections that are meant to assist policymakers in their energy policy deliberations. The AEO2007 results that I have discussed this morning are intended to serve that broad purpose. EIA has also completed several analyses of the energy and economic impacts of alternative proposals to limit greenhouse gas emissions over the past several years.

We look forward to providing whatever further analytical support that you may require on topics ranging from greenhouse gas limitation to energy security challenges facing the Nation to the impacts of policies to promote greater use of renewable energy sources. We believe that such analyses can help to identify both potential synergies and potential conflicts among different energy-related objectives that are currently under discussion in this Committee and elsewhere.

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. I think, obviously, there's a lot to ask about.

Let me ask a few questions. We'll just have 5-minute rounds.

You have various scenarios set out in you Annual Energy Outlook. With regard to bio-fuels though, my layman's view of what you're saying on bio-fuels is that there's no way we can achieve the kinds of targets that the President has set for 2017, in terms of bio-fuel production—35 billion gallons of bio-fuels by 2017.

Is there any scenario that you could envision that that could be achieved?

Mr. CARUSO. To clarify, what I'm saying is that under these assumptions, which are the economics that we have in this model, the technology as best we know it for converting cellulose into ethanol, as well as the existing policies, gets—in this reference case—around 12 billion gallons in 2017.

The CHAIRMAN. Twelve, does that include corn?

Mr. CARUSO. Almost all of that is corn-based because of the—as I mentioned, the economic assumptions and the technology, the capital cost of producing ethanol. So, is it possible to get there? This is a very ambitious goal that you've mentioned. We need a lot more information to be able to answer that question. There are a number of factors that we still don't know about in the proposed mandate. I think Administrator Johnson, at a hearing yesterday, mentioned that there would be forthcoming legislation laying out the President's proposed mandate in detail.

Until I were to see what those proposals actually included—there's a safety valve included in that, and other renewables and alternative fuels in addition to ethanol—I would say I'd be reluc-

tant to say there's no scenario that would get you there. The scenario that I've outlined gets you to about 12 billion.

The CHAIRMAN. Gets you to 12 billion gallons, instead of 35?

Mr. CARUSO. Yes, sir.

The CHAIRMAN. On nuclear production of electricity from nuclear power—as I recall it in the outlook that you gave us last year—I remember having a discussion with you last year about what your projection was there. You anticipated that there would be some increase in production of electricity from nuclear power for some period of time through, I think, 2017 or 2018 at which point, the increase in production of power from nuclear would flatten—would go away, and we would just stay where we were because of the tax provisions that we wrote into EPAct.

Is that still your view, that there's going to be some improvement between now and 2017 or 2018, and then at that point we're just where we are?

Mr. CARUSO. Well, I think in this reference case, we're assuming there'll be nine new nuclear plants built at existing sites by 2019, I believe it is. I'll get further clarification of that. So we would have a steady increase in the production of electricity from nuclear as those new plants came on stream. In this scenario, that would tend to flatten out. However, as I mentioned, there are a number of side cases depending on——

Okay, I'm told we do build some additional plants beyond 2020 in this outlook, but those are the nine new plants, giving you about 12 gigawatts of new capacity in this outlook.

The CHAIRMAN. So, what percent of our electricity do you anticipate in 2030 would come from nuclear power?

Mr. CARUSO. About 15 percent.

The CHAIRMAN. Fifteen.

Mr. CARUSO. It's around 19 now.

The CHAIRMAN. It's 19, so it will be down to 15 by 2030, given current expectations with regard to plant construction.

Mr. CARUSO. That's correct. I mentioned 54 percent of new generation capacity would be coal-based in this outlook.

The CHAIRMAN. So coal gets a bigger and bigger portion of our——

Mr. CARUSO. Its share grows from 50 to 57 percent, and the share of nuclear goes down. The share of natural gas goes down, and the share of renewables goes up slightly.

The CHAIRMAN. Okay, that's it, my time's up.

Senator Domenici.

Senator DOMENICI. Mr. Chairman, you could go on as long as you'd like.

The CHAIRMAN. No, go ahead.

Senator DOMENICI. Thank you. I—I imagine somewhat like you—am looking at nuclear, and it looks like the more we do, the less we get. We seem to be going nowhere.

Add to it, Mr. Chairman and fellow Senators, and I'd say this to you Mr. Caruso, the scenario that I'm getting out of Tennessee, where they're building a new plant as part of the Tennessee Valley Authority. Not a new plant, but they had one that was stopped at about half, and it stayed at half until recently, and they made a policy decision to do it. Mr. Caruso, I understand—and it might be

worthwhile so that I'm not just talking on the record here for nothing and may be wrong—but I understand they are having a terrifically difficult time getting the kind of personnel to build this plant. I want to make sure that I'm stating it right, but Mr. Chairman, I understand they can't find enough welders. It takes some simple little proposition. Very highly paid, ready to hire as many welders as there are available for jobs as welders in the United States, in the whole United States.

They've run ads in big papers saying, "If you're in L.A., if you're in Chicago wherever you are—if you're a welder and you want a job for"—I don't know, 18 months or something—"would you move to so-and-so, we've got a job for you." And they haven't even filled them with that.

Now just think of that. If it's the case, if it's a matter of fact, that we're going to license—let's just gamble and say we license four before Christmas. And if it's the same, they're going to apply for permanent licenses. I don't know how long it is before they look for steel, before they look for steel workers, Mr. Chairman, and all the others things that go into building a plant. But I have the sneaking hunch that we're going to have somebody up here telling us and Senator Bingaman's going to say, "Why are they so delayed?" They're going to tell us, "We don't have any steel workers."

Or, I heard a good one recently. You know those big pots that go in the middle of nuclear power plant, into which they put the steam. There's only on place in America building them today. I was talking to my friend who has a genuine interest, Senator Craig, and we were saying, "Isn't it incredible?" We don't have a capacity to build those. We can build a small one, but not the big one. And even the French can't, with all their prowess in nuclear power. The only country that can build one is South Korea. And do you know what? The countries are gutsy enough right now to order them in advance, and get their name on saying such-and-such utilities is putting a down payment, and I'm buying whatever this thing is called, even though I don't know when I'm going to build my plant. But I know I'll be ready before you have one built, so I'd like to buy one.

I'm just amazed that this kind of thing enters your configuration, as to why we won't move with more dispatch. It's a simple one, a fundamental one, but I think it's harsh. Because I don't know how many young men and women are going to want these jobs. They're going to pay $25 an hour, and I wrote down your State, Senator where they're building this power plant. It's big pay, isn't it? And they can't find enough workers. I'd just like to lie that before you.

Senator CORKER. Yes, sir.

Senator DOMENICI. I have two more quick questions.

Mr. CARUSO. It does get reflected in the assumptions we use—that these types of human resource scarcities as well as commodity scarcity, precious metals, steel, concrete—all have increased the cost of doing business in every sector, from petroleum through electric power. We try to keep up with them, but it's moving so fast that—for example—in the exploration and production of oil and gas, the cost index has gone up 50 percent in just 2 years. That's pretty extreme; that's not sustainable. Even when you look at the 10-year track record, it's been increasing in double digits per year.

The cost of finding, developing, and producing oil and gas—it's one of the reasons why we think we're not going back to $25 or $30 oil.

Senator DOMENICI. Well, I just want to close with one last observation and question.

It seems to this Senator that the coal people—that is, those who own coal that can be used for future utility coal-burning purposes—ought not be terribly worried about whether they're going to stay in business with all these alternatives. Because every one, every authentic study—including yours—would show that in spite of everything we're doing, there will be more coal, not less. You are going to do nuclear, but you're going to have more coal, not less. We've got Japan adding nuclear, but they're just adding coal like running water. Turn on your water faucet, and there comes one every day. What is it, every 3 days, or an average of every 10 days or something?

Senator CRAIG. China.

Senator DOMENICI. So I don't know why the coal companies are worried about a policy that might intend to take their business, jobs, and capital and knock it down. It's going to be out there, in front and center, for the alternatives aren't going to make it budge very much.

But I think we haven't done a very good job implementing our bill, in terms of making capital available for some alternatives. Not to brush coal aside, but to just offer some competition. And that's why, you even mentioned a lack of parts of the bill being implemented for loan guarantees, that you even saw that, Mr. Craig, on the horizon, right?

Senator CRAIG. Yes, sir.

Senator DOMENICI. And we are trying our best, we want you to know, to see to it that the U.S. Government does something about the policy commitments in the law to get on with some of these things that we know we intended to spend money on.

I'll have some written questions. I'll get them to you. One will be this, and you can answer with your staff. I'd like a little historical summary about how we might mobilize to get workers ready for the kind of jobs that nuclear might be presenting to them. Starting with the proposition: are there any out there, anyone trained? If not, how are we going to train them? How have we done it in the past? I think it's probably a winner for somebody that wants to go into the business of training. The U.S. Government for one, but I stop at that. Thank you.

Mr. CARUSO. Thank you.

[The information follows:]

With the lack nuclear plant orders in the United States since 1978, there has been a consolidation in the nuclear industry and many nuclear plant component manufacturers, suppliers and construction companies are no longer in that business. In addition, the nuclear work force has aged and retired without the influx of new and younger people to take their place. As such there is a serious shortage of qualified construction craft, operations and maintenance technicians, and engineers to work in the nuclear resurgence.

A 2004 Bechtel study found that if 50 gigawatts of new nuclear capacity were built before 2025, over 100,000 manufacturing, construction, and operating jobs would be created in the United States. Announcements by more than a dozen power companies of their intentions to submit applications to the Nuclear Regulatory Commission for combined Construction and Operating Licenses (COLs) for as many as 33 new nuclear reactors (representing at least 40 gigawatts) are a marketplace indi-

cation that new jobs may be created as COLs are approved and new orders are placed. Similar motivation in the mid-1960s when reactor orders were pouring in at rates exceeding 20 per year led workers to acquire the skills necessary and fill the jobs being created.

As part of the NP 2010 program, the Office of Nuclear Energy funded an independent review of the nuclear power plant construction infrastructure. That report, which is available in its entirety on the NP2010 website (http://nuclear.energy.gov/np2010/reports/mpr2776Rev0102105.pdf), concluded that more generic construction trades are sufficient to build the first wave of about eight new reactors. The more specialized trades, including boilermakers, pipe fitters, electricians and iron workers are in short supply, and these workers will need to be brought in from all regions of the country to build the first plants. The reactor vendors and the engineering, procurement and construction contractors are aware of the potential shortages in specialized skills. National programs, sponsored by industry and the U.S. government, as well as unions, community colleges and career training centers, are all providing training opportunities for the construction trades. The challenge has been to recruit U.S. citizens into the more technically demanding, albeit highly paid, construction trades.

While it appears that there are a number of programs ongoing to close the gap on workforce requirements for nuclear power plants, additional review is warranted. The Nuclear Energy Institute (NEI) is conducting a FY 2007 workforce study that is a follow-on to their 2003 and 2005 staffing studies looking at nuclear staffing needs for the existing fleet. The new study should be completed by the end of May. NEI has also worked with the Southeast Manpower Tripartite Alliance to examine skilled craft supply and demand in the southeast with a view toward new nuclear plant construction. These studies will provide additional insight into the availability of workers for new plant construction.

The CHAIRMAN. Thank you.

Senator Tester.

Senator TESTER. Thank you, Mr. Chairman.

In your projections and studies, did climate change have any impact on your projections?

Mr. CARUSO. We do estimate the CO_2 emissions from energy sources in our outlook. To the extent that there are any policies in place, in terms of renewables, fuel standards, or portfolio standards, we incorporate all of those—whether they be at the State or local level. As you know, we don't have a Federal renewables portfolio standard. We incorporate any policies that are in place as of the end of last—or toward the end of last—year in this outlook. To that extent they're included in there, but that's it.

Senator TESTER. So potential carbon sequestration costs are not part of the equation?

Mr. CARUSO. We looked at carbon capture and sequestration technology and the current economics and, at the present time—or when we did these runs—the cost and the technology are not to the place where they are implemented in this outlook.

Senator TESTER. Okay. All right.

Then you talked about the ethanol from corn reaching about 12 billion, if I heard you correctly.

Mr. CARUSO. In 2017.

Senator TESTER. Yeah, and you said that that was from both—was mainly from corn, but was also from cellulose.

Mr. CARUSO. A small amount.

Senator TESTER. Did you break that down?

Mr. CARUSO. Yes.

Senator TESTER. How much was it from cellulose?

Mr. CARUSO. The cellulosic ethanol component, in 2017 is around 240, 250 million gallons. That's based on the requirement in the Energy Policy Act of 2005. That's mandated by the EPAct 2005.

Senator TESTER. Okay. So it's based more on mandates than it is on potential?

Mr. CARUSO. That's correct. The current economics and current technology strongly favor corn-based ethanol in this country, and sugar-based ethanol from foreign sources.

Senator TESTER. All right, okay.

Was there, I mean—and excuse me if you went over this—but the coal-to-gas projections: were there any projections on that for electricity and gas, and potentially even fertilizer, things like that?

Mr. CARUSO. Yes. Part of the strong growth in coal production in this outlook, going from a little over 1,100 million short-tons to 1,800, is the use of coal for conversion to liquids. In the reference case, it's a couple hundred million short-tons, and that adds up to about 400,000 barrels a day of liquid fuels in the reference case. That's at roughly $55 per barrel of oil equivalent. But if you get a high-price case, that number can go much higher. Our high-price case gets up to 1.7 million barrels a day of liquids from coal, and that's at almost $100 a barrel in real terms in 2030.

Senator TESTER. So, what you're saying is, then, with today's technology—if you extrapolate that out, $55 a gallon is where it's profitable. Is that what you're saying?

Mr. CARUSO. I'm saying even lower than that—probably closer to $45-per-barrel oil equivalent. It is a sufficient economic incentive to convert coal to liquid.

Senator TESTER. Does the quality of the coal have any bearing on that $45 figure that you talked about? For example, there's different quality of coal in Montana than there is in West Virginia than there is in North Dakota. What are the impacts of that?

Mr. CARUSO. I'd have to answer that for the record. I don't know the exact differences between the yield of liquids based on different qualities of coal, but I'm sure there's a difference. We're basing the economics on the Fischer-Tropsch method that's been used by Sasol in South Africa.

Senator TESTER. Okay, so the kind of coal that's used in that Fischer-Tropsch method: was that looked at, at all? Was it a lignite, a bituminous? Was that looked at, at all?

Mr. CARUSO. I'm sure it was, but I don't have, off the top of my head, the specific type of coal we used in this projection.

Senator TESTER. Something that I'd be curious about, if you have it in your wherewithal, is what kind of coal yields the highest percentage of product? Now I would assume that it's, like we taught in school——

Mr. CARUSO. Uh-huh.

Senator TESTER [continuing]. You know, the three levels are the best, but I don't know that, and it would be good to know that.

Mr. CARUSO. I'd be happy to provide that for you.

Senator TESTER. Thank you.

[The information follows:]

The major available coal types in the United States (bituminous, subbituminous, and lignite) can be converted into liquid transportation products. For Fischer-Tropsch technology, an indirect route to liquids through gasification of the coal, the amount of liquids produced is directly related to the coal rank (the heating value of the coal). For a bituminous coal, the yield of transportation liquids is about 2 barrels per ton; for sub-bituminous, about 1.6 barrels per ton; and for lignite, about 1.1 barrels per ton. These estimates are for self-sustaining plants, where the energy for

operation of the plant is derived from coal or coal products. While the respective yields by coal rank would seem to favor the use of bituminous coal, the lower production costs for U.S. subbituminous and lignite coals can actually make them the more cost-effective fuels and feedstocks for CTL plants. In 2005, the average minemouth price of subbituminous coal produced in the Powder River Basin (WY, MT) was less than $8 per ton, and the price of North Dakota lignite was about $10 per ton. By comparison, the average minemouth price for bituminous coal produced in the Eastern Interior (IL, IN, KY west) in 2005 was about $27 per ton, and Appalachian bituminous coal sold for an average price of more than $40 per ton.

The CHAIRMAN. Senator Craig.

Senator CRAIG. Thank you, Mr. Chairman.

Mr. Caruso, thank you for being with us this morning.

EIA's work has been extremely valuable to us over the years, and your presentation here this morning ought to be—at least—somewhat alarming to all of us, as it relates to our growing dependency on foreign sources, and the hurdles that we have to overcome.

Even with the Energy Policy Act of 2005 and the beginning of what is happening out there in the energy field, in all types of energy, obviously when you begin to do what you all do well—and that's extrapolate and measure and put it into context—it changes the picture somewhat.

If by 2012, 8 billion barrels of ethanol production is where we will be, and as of close of business this year we were at a certain level that consumed 20 percent of the corn market, obviously to arrive at where we need to get, with what the President's talking about, or even what you're projecting, would suggest that in the American food chain, corn and its dynamics have to change a great deal. Do they not?

Mr. CARUSO. That's correct. Even getting to the numbers, in our reference case, which are 12 billion gallons in 2017, it's more than 30 percent of, I don't have the specific——

Senator CRAIG. Right.

Mr. CARUSO [continuing]. I can't provide the specific number, but it's more than 30 percent of the corn crop.

Senator CRAIG. Have you factored in—I assume you're looking at static, I should say—current production levels based on yields per acre and acreage available. How do you arrive at those numbers?

Mr. CARUSO. We have looked at that, and we do work with the Department of Agriculture in——

Senator CRAIG. Yeah.

Mr. CARUSO [continuing]. Their crop forecasts and with their chief economist, Keith Collins, in comparing that data. So we do work with them, and that's included in our model.

Senator CRAIG. You factored in—I think Senator Tester mentioned or you came with the figures—as it relates to cellulosic, a relatively low number.

Mr. CARUSO. Yes.

Senator CRAIG. Senator Domenici had mentioned a company, and a grant, and an anticipated loan guarantee to get some commercial activity going in the cellulosic area. There are many of us who've paid a good deal of attention to that, thinking that it is a valuable source, and to get to where the President is talking, you have to factor that in to a more significant number. Would you agree with that?

Mr. CARUSO. I would absolutely agree. As I mentioned earlier, these are the assumptions on current economics, the current state of knowledge and technology, and we certainly hope that these grants that were announced yesterday, and a number of other programs that are on the way, will change that technological——

Senator CRAIG. Sure.

Mr. CARUSO [continuing]. Picture.

Senator CRAIG. So when we go from 19 percent nuclear to 15 percent, and coal picks up the margins and grows—and yet I watch now where there's an attempt to site current technology coal plants, a very strong resistance on the part of the region or the area in which the siting is attempted. What are you factoring into this phenomenal coal growth as a part of electrical production, as it relates to technology in those plants?

Mr. CARUSO. Well we——

Senator CRAIG. And, i.e., climate change, and all that we're looking at now.

Mr. CARUSO. As I mentioned to Senator Tester, we did look at the current economics and technology of carbon capture and sequestration, and at these prices, we don't have that in this reference case.

Senator CRAIG. Okay.

Mr. CARUSO. In the coal sector as a whole, we see continued steady improvement in efficiency, both the combination of pulverized coal at the use of the highest technological availability, as well as a significant new amount of IGCC plants. I think almost half of the new coal-fired plants in this outlook are IGCC, Integrated Coal Gas Fired Combined Cycle.

Senator CRAIG. Oh, all right.

Mr. CARUSO. I may have the numbers slightly off, but I think for about a 41 percent growth in electricity generation, you'd do it with about a 33 or 34 percent increase in energy. So, you're getting more electricity by using less energy per unit of measurement in the coal sector——

Senator CRAIG. Right.

Mr. CARUSO [continuing]. In both pulverized and the IGCC techniques.

Senator CRAIG. Yeah. Yeah.

Mr. Chairman, my time is about up.

Let me ask: Senator Domenici asked that I change the record based on a statement he had made. Currently it's Japanese Steel Works that can forge the reactor vessel containers that he had mentioned. It appears that a Korean company is gearing up to supply those. So, I wanted to do that for the correction of the record in relation to what Senator Domenici had said.

Senator Domenici also talked about, obviously a sense of concern as it relates to crafts and skills and the capability of the American work force. As we debated EPAct a couple years ago that became quite apparent to us, especially in the nuclear field—that this really was a gearing-up, again, of an industry that we had lost a large part of or had put in an idle mode for a long, long while. And in your analysis of 7, 8, 10-plus reactors, do you look at that gearing up? Not only the nuclear physicists, the young student at the college and the university, but the skilled technician, if you will. The

skilled welder, the quality of work, and the type of work, that will be required to meet that licensing responsibility under the NRC.

Mr. CARUSO. We don't go into a great level of detail, but it does reflect itself in the higher costs, the higher capital and construction costs of building these new plants.

Senator CRAIG. Okay.

Mr. CARUSO. It's been rising steadily along with, as I mentioned, the costs of doing business in oil, gas, and in the electric utility industry in general.

Senator CRAIG. Sure.

Mr. Chairman, my time is up, but let me say to you, and to the committee, and for the record: I grow increasingly alarmed at reality when I see these figures. I know where we can go. I know what we've done, and how long it took us to get to where we are today, from a policy standpoint. Yet, I see agencies not performing at levels, and a sense of urgency that I would hope we could have. I really do believe whether it's the executive branch or the Legislative Branch, we need to declare war, in a sense of a deployment of resource and talent in a way that we've not done before, to focus on our energy needs.

It just makes not only good sense for our country to do that, but we will grab a leadership role once again in new applied technologies that we're so very good at doing if we martial those kinds of resources. I'm always frustrated about gas pipelines coming out of Alaska and what it's going to take to get it. Whether it's resource deployment, or talent deployment, or the frustration of a lack of quality public policy that gets us to where we need to get in a timely fashion. America becomes the loser if that urgency doesn't exist. While we've moved, while we've nudged the noodle a bit, I think we—your leadership, our leadership—needs to nudge it a good deal more in a most urgent way. Thank you.

The CHAIRMAN. Thank you.

Senator Murkowski, go right ahead.

Senator MURKOWSKI. Thank you, Mr. Chairman.

Good morning, Mr. Caruso. I always look forward to the Annual Outlook. I wish our outlook looked better. I want to talk just a little bit this morning about natural gas.

As you know we're waiting anxiously, from the State's perspective—the new Governor is rolling out her new legislation of inducements to get participants so we can get this gas line moving forward. But, you know, when we passed the natural gas pipeline out of the Congress, we anticipated that Alaska's gas would be online in about 2012. A couple years ago the projection was it was going to be here in 2014. Last year when you came to speak to us the assessment was going to be 2016. This year you bumped back to 2018. So it seems like every year you'd come to talk to us we lose a couple years with getting Alaska's gas to market, which is a huge concern to me as an Alaskan, a huge concern to me as an American, knowing that we've got to meet this demand. I'm particularly troubled as you look at your report and the increase that we're seeing in the out years for imported LNG.

Now I don't know—you've indicated that our reliance on foreign sources of oil is about 60 percent. What is it, currently, for LNG

now and what do you project our imported LNG to be in 2030? Do you have those numbers?

Mr. CARUSO. Last year we imported about 6 trillion cubic feet in the form of LNG and our total consumption was 22. So about 3 percent——

Senator MURKOWSKI. Yeah.

Mr. CARUSO [continuing]. Roughly 3. We see that going up to perhaps, in this base case—4.5 trillion cubic feet out of 26. So, getting close to 20 percent.

Senator MURKOWSKI. Close to 20 percent.

Mr. CARUSO. Yes.

Senator MURKOWSKI. Tell me what happens to your projections should we encounter more problems in getting Alaska's gas to market. Where do we go?

Mr. CARUSO. I think if you were to say to me, I now think we can't, we're not likely to have——

Senator MURKOWSKI. I'm not saying that, and I will not say that. I'm not going to give up on it.

Mr. CARUSO. If someone else said that, I would say almost on a Btu-by-Btu basis, it would probably be replaced by LNG. There'd be a slight increase in the price——

Senator MURKOWSKI. Right.

Mr. CARUSO [continuing]. If we didn't get the Alaskan gas. So that would affect demand a little bit. The total would come down a bit. But the incremental supply of gas, and we've got a case in here which shows that very clearly, how LNG——

Senator MURKOWSKI. LNG comes in.

Mr. CARUSO. It swings enormously based on——

Senator MURKOWSKI. Right.

Mr. CARUSO [continuing]. The alternatives of supply, which include certainly, Alaska——

Senator MURKOWSKI. So, in other words——

Mr. CARUSO [continuing]. And price.

Senator MURKOWSKI [continuing]. We continue down that path, as a Nation, of increased dependency on foreign sources, not necessarily of oil this time, but natural gas, which is a place——

Mr. CARUSO. Exactly.

Senator MURKOWSKI [continuing]. That is absolutely unacceptable in my opinion.

Mr. CARUSO. That would be what our model says.

Senator MURKOWSKI. You mentioned the enormous increases that we're seeing in our costs for oil and gas production, some 72 percent over the past 4 years attributable to the steel costs. I was looking through press clips this morning. This is an article about Conoco, Conoco's earnings, and they indicate that on a per-barrel basis, oil production in Alaska became considerably more expensive last year, averaging $6.38 per barrel compared with $3.91 the prior year. What we're seeing in terms of production costs is just going through the roof. What does this mean to us, as we try to build a gas pipeline, recognizing how production costs are going up? And this is probably a little bit of a rhetorical question, but give me your answer here.

Mr. CARUSO. What it means is that when companies look at projects, particularly in the upstream—exploration, production, and

delivery—they're looking to meet a certain rate of return. They will be looking at the need for higher and higher prices to be able to achieve that rate of return.

Senator MURKOWSKI. Because of the costs.

Mr. CARUSO. Clearly, costs it will affect investment. I think that if you're looking for what's the indicator to reflect these increases in costs, I would look at companies' investment budgets, particularly in the upstream.

Senator MURKOWSKI. Let me ask you about oil.

In looking at the report, you're predicting that oil production from Alaska will decline from roughly 860,000 barrels of today, to just about 270,000 barrels in 2013—if we fail to open up ANWR. In other words, if there's no new fields coming online in that area.

This is particularly worrisome as we hear the reports and understand the prediction of many, that it may be very, very difficult to keep the pipeline operating at such greatly reduced flows. Several different reasons for this, but does your forecast take into account in any way that with a decreased level of production—as you're predicting—what happens to Alaska oil production if, in fact, all these forecasts prove true?

Mr. CARUSO. Well, the numbers you cited are right on. I mean, we do see a steady decline given the current policies, and the price assumptions, and technology assumptions. There is a point which the Trans-Alaska Pipeline System cannot go below, in terms of volume, that would be needed to keep the economics of that pipeline favorable for running.

So, I'm assuming, I'm sure we've taken that into account, that's getting pretty close to my recollection of what the minimum flow would be required to be.

Senator MURKOWSKI. Yeah, and one last very quick question. This is regarding OCS, and recognizing that you're factoring in additional oil production—future production from OCS waters. How much do you account coming from Alaska?

Mr. CARUSO. The specific OCS component of Alaska?

Senator MURKOWSKI. Yes.

Mr. CARUSO. I don't have that off——

Senator MURKOWSKI. Okay, you can let us know.

Mr. CARUSO [continuing]. I'd be happy to provide it for the record.

[The information follows:]

EIA oil production projections off the Alaskan coast are not identified specifically as originating in state versus Federal waters. It is likely that an increasing portion of the total offshore oil production will occur in the OCS. EIA's projections for total offshore oil production in Alaska are as follows:

CRUDE OIL PRODUCTION (THOUSAND BARRELS PER DAY)

	2005	2010	2015	2020	2025	2030
Offshore Alaska	119	54	169	282	143	64

Senator MURKOWSKI. Great.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Landrieu.

Senator LANDRIEU. Thank you, Mr. Chairman.

I want to follow-up from my colleague from Alaska, because I share many of her concerns, particular as it relates to the supply of natural gas and our necessity of increasing domestic production and in a safe and environmentally-friendly way.

The natural gas production from the Gulf is—according to your study—likely to decline after 2015 because in your testimony, "investment is inadequate to maintain production levels". Could you describe or comment on that statement?

Mr. CARUSO. Yes. Given the cost of developing the conventional sources of gas in the OCS in the Gulf of Mexico, we see the cost of doing that increasing, and the ability to keep that production level from declining increasingly difficult. We see more and more of the total share of gas moving into what we label as unconventional, unsure sources of the Rocky Mountains or the tight sands, coal-bed methane, and the shale gas play. Fifty percent of the gas supply in this outlook by 2030 moves—if you will—from traditional sources such as offshore, particularly the shallower waters of the OCS to unconventional sources.

Senator LANDRIEU. Now, I want to be very clear about this, because I think this is very important. Are you testifying that, because there are significant expenses associated with retrieving gas offshore—particularly in deep water—that production will move back onshore to non-conventional ways of extracting gas in places that might have difficulty with permitting? My reading of that process might lead one to believe there are fairly significant environmental consequences of this non-conventional gas.

Mr. CARUSO. I'm just saying the economics of developing gas becomes more and more unfavorable as they go after more difficult and smaller deposits and they're unable to take advantage of the economies of scale. That's basically what's going on. It's a traditional long-term decline.

Senator LANDRIEU. Because this is very concerning that, Mr. Chairman, this committee has an—I think, an obligation, an important duty to face this country in the right direction. If there are substantial deep water reserves that, with the right incentives, can be tapped, as opposed to driving the production to places where it's more marginal, and more difficult, and potentially it could have more environmental negative and environmental consequences. I think that's something we need to look at.

My next question is, do you think it's wise for this Congress to be cutting back on some of these incentives based on what you have testified this morning?

Mr. CARUSO. We don't really comment on policy, but that certainly is the implication of this outlook. Given the policies currently in place, and the economics of offshore development—we continue to see a steady decline in that traditional source of gas.

Senator LANDRIEU. Let me just be clear for those that are honing in on this argument, that your projections estimating natural gas prices and oil prices to be about what, between now and 2030—so what are your estimates?

Mr. CARUSO. Our current reference case has the average wellhead price of gas trending down between now and the middle of the next decade to about $5 per MMBtu, then increasing back to about $6 MMBtu by 2030.

Senator LANDRIEU. The point of this question is that, even with your estimates of relatively high prices, historically high prices, the investments still will wane, driving this change of policy.

I know my time is up, but my second real brief question is: Have you taken into account—I know you're projecting an increase of liquefied natural gas—but have you taken into account the difficulty of permitting these facilities? For the record, how many are actually up and running, and permitted, and where are they generally located?

Mr. CARUSO. Well, there are the four existing onshore plants.

Senator LANDRIEU. Where are they?

Mr. CARUSO. In Everett, Massachusetts; Cove Point, Maryland; Elba Island, Georgia; and Lake Charles, in your State. And now there are four under construction.

Senator LANDRIEU. Where are they?

Mr. CARUSO. They're all in the Gulf region—Texas and Louisiana.

Senator LANDRIEU. For the record, are we having difficulty permitting these facilities in other places outside of the Gulf?

Mr. CARUSO. As of now, there are no permits beyond the FERC and the Coast Guard for outside of the Gulf.

Senator LANDRIEU. Thank you.

The CHAIRMAN. Let me ask about renewable energy generation from non-hydro renewables. What is the current percentage of our electricity produced from non-hydro renewables, and what do you see it going to in 2030?

Mr. CARUSO. I think the current number is a little more that 1 percent of non-hydro renewables—sorry, I'll get a more accurate number. It's 2.2 percent right now, going to 3.6 in 2030.

The CHAIRMAN. In projecting that, let me just break it down a little more. Wind energy, you see increasing somewhat over the next few years, but then leveling out. Is that what I understand your projection to be?

Mr. CARUSO. I believe that's correct. Wind is the fastest growing of that non-hydro pertfolio.

The CHAIRMAN. Is that because of the fact that the production tax credits are expiring?

Mr. CARUSO. Yes.

The CHAIRMAN. You've assumed that they are not renewed?

Mr. CARUSO. We assume for renewables, that the tax credit expires.

The CHAIRMAN. At the end of 2008?

Mr. CARUSO. Under the current law. We know that the history has been that there have been multiple extensions of this, but we do not assume that it would happen in the future.

The CHAIRMAN. Is it possible to do an estimate of what you think would be possible to do with renewables, either wind or solar, if we did extend those production tax credits for 10 years or through 2030?

Mr. CARUSO. Yes, we have done a side case.

The CHAIRMAN. What is the difference there? Instead of going to 3.2, what would we go to?

Mr. CARUSO. It's fairly significant. I don't know if someone has it, but I would be happy to provide it for the record. We did do a

model run base on this outlook which does assume that the production tax credits are extended——

The CHAIRMAN. Yeah, that would be——

Mr. CARUSO [continuing]. Ten years.

The CHAIRMAN [continuing]. Very useful to know how that would change the prospect for shifting to renewable energy.

Mr. CARUSO. Here it is.

For example, for wind, by 2017 we project total in installed wind capacity of about 33 gigawatts, with the extension. In the reference case, without the extension, it's 18 gigawatts.

The CHAIRMAN. So——

Mr. CARUSO. And we've done that.

The CHAIRMAN [continuing]. Nearly a doubling——

Mr. CARUSO [continuing]. Yes.

The CHAIRMAN [continuing]. Of——

Mr. CARUSO. It makes a big difference.

The CHAIRMAN. Okay. And the same could be assumed with regard to solar energy—production from solar energy?

Mr. CARUSO. I don't have solar here, but, for example, geothermal would increase by 700 megawatts by 2017 to 3 gigawatts with the extension. I would have to provide the solar number for you.

The CHAIRMAN. Okay.

Mr. CARUSO. But, it's much smaller.

The CHAIRMAN. Right. But it still would be substantially larger were we to extend the production tax credit than to just allow it to expire at the end of 2008?

Mr. CARUSO. That's correct.

[The information follows:]

EIA prepared an analysis of a 10-year Production Tax Credit (PTC) extension at the request of the Congressional Joint Committee on Taxation. The Committee specified an extension of the technology in-service deadline for PTC-eligibility, without any further modifications of current PTC law. However, since solar is currently not eligible for the PTC, its penetration was not affected by the extended PTC.

Currently, solar technologies are eligible to receive an Investment Tax Credit (ITC) worth 30 percent of investment costs. For commercial entities, this credit reverts to its permanent value of 10 percent at the end of 2008 (the Annual Energy Outlook 2007 reflects the then-current 2007 expiration of the 30 percent ITC). For residential installations, the credit expires completely at that time. The Committee did not request an extension analysis of the 30 percent ITC, and EIA has not otherwise performed such an analysis. However, an extension of the ITC would be expected to increase installations of photovoltaic systems relative to the Annual Energy Outlook 2007 reference case.

The CHAIRMAN. You have something in your forecast about potential for excess production capacity for ethanol in the near term, as I understand it. As the capacity increases, it's expected to outpace the demand in the next few years. Could you just explain what that is, and what the problem there is?

Mr. CARUSO. In our short-term outlook, which we do every month, we look at demand for gasoline, and what the blending component of that would be accounted for by, in this case, ethanol. What we see is the availability of ethanol with the increasing production announced, the number of plants that have been announced, increasing faster than what we think will be required as a blending component in the total gasoline pool. We have that only going up to—even in the long-run—about 8 percent of the total gas-

oline pool. We think there'll be more corn-based ethanol capacity, in the near-term, than there will be demand for it in the gasoline pool.

The CHAIRMAN. So, in order that all of the ethanol that we're planning to produce actually be needed or used, you're saying that we need to also increase the requirement for blending of ethanol from where it is today. Is that what I'm understanding?

Mr. CARUSO. All I'm saying is that right now, it varies by refiner, and most are blending at about 10 percent in their use of ethanol. California is 5.7 percent. It appears that the pace of production of ethanol is moving quicker than the demand for the use of that as a blending component. Therefore, last year when we testified, the price of ethanol had risen dramatically since it was needed to replace MTBE as an oxygenate component, and that short-term demand to replace phasing out of MTBE was met with reasonably efficiently. Now we've gone past that in terms of the supply of ethanol needed. We're looking at a relatively softer market for ethanol this driving season than last driving season.

The CHAIRMAN. Okay.

Senator Tester.

Senator TESTER. Yeah, thank you, Mr. Chairman.

Guy, thanks for being here today. I mean, this has been very interesting.

I want to switch gears a second, and I want to talk about foreign oil and what impact it had on your Energy Outlook for America. I mean right now—and I'll get more specific—right now we import a fair amount of energy. Were you using the same ratios moving up, or were you making some assumptions that we were going to wean ourselves of, particularly, the Middle Eastern oil?

Mr. CARUSO. The outcome of this business-as-usual reference case is that our net import dependency will go down over the next 5 to 7 years as we bring on some deep water offshore production in the Gulf of Mexico. By the end of this projection period it's back to about where we are now——

Senator TESTER. Okay.

Mr. CARUSO [continuing]. Which is roughly 60 percent——

Senator TESTER [continuing]. Okay.

Mr. CARUSO [continuing]. Of import dependency.

Senator TESTER. Okay, and then was conservation looked at? Because what I'm getting at is often times when you anticipate energy production, a lot of it's market-driven. In fact, it's probably all market-driven. So, was there any conservation percentages pumped into the analysis?

Mr. CARUSO. We do have embedded within this projection increasing efficiency in the use of all energy, but, in particular, liquid fuels, as people buy more efficient vehicles. We have hybrid sales growing steadily, even dieselization of the fleet increasing.

Senator TESTER. Did you use a flat percentage figure increase every year? Or what did you use?

Mr. CARUSO. No, what we try to do is look at it on a sector-by-sector basis—for example, in the automobile sector we have growth in miles per gallon per vehicle going at about 2 percent per year in that case. Then other factors that could be put into that category of efficiency of conservation include consumer behavior. We do ac-

tually see a slowing down of the vehicle miles traveled per driver over this time frame. That's partly demographics, with the aging of the population and the movement of our population toward the South and Southwest.

Senator TESTER. Okay. So it would be fair to say that you can not project what may come out of this body as far as measures that may encourage more public transportation or house, home business, heating, that kind of thing, fertilizer use, I mean the list goes on and on. It's really very difficult to project that until you know what the policies are?

Mr. CARUSO. That's correct.

The other overriding issue is one of our general economy. We continue to see a movement away from energy-intensive consumption particularly in the industrial sector. If you look at this on a global basis, where is it moving? It's moving to China and other Asian——

Senator TESTER. I've got you.

Mr. CARUSO. So.

Senator TESTER. Okay, well thank you very much. I appreciate your time.

Thank you, Mr. Chairman.

Mr. CARUSO. Thank you.

The CHAIRMAN. Thank you.

Senator Murkowski.

Senator MURKOWSKI. Thank you.

Mr. Chairman, your comment that prompted the response about geothermal encouraged me to stay for another round.

I have really gotten very excited about the potential for geothermal, not only in Alaska, but around the country. On page 162, we found your projections here as you look at geothermal through the out-years, and you're predicting a annual growth in the geothermal area of 1.6 percent.

When you make these assumptions—and this goes to the Chairman's question—do you factor in policies that we put in place that would allow for, whether it's tax credits or—how do you arrive at that particular rate of growth in the area of geothermal?

Mr. CARUSO. Similarly to other renewable sources, we look at the economics of existing sites for potential—as well as the policies you mentioned, the production tax credit—and try to make a best judgment as to where the increase in the supply of that particular technology would occur, and when it would come on stream.

Senator MURKOWSKI. So, if we would get more aggressive here in the Congress or in the administration in support of geothermal, your outlook would theoretically be changing down the road?

Mr. CARUSO. We certainly look, every year, for any changes in Federal, State, and local laws, and try to incorporate them in the outlook, particularly with things like renewable portfolio standards, now adopted in a large number of States.

Senator MURKOWSKI. We'll bring you up to Alaska and show you what we're doing up there. It's really very, very exciting.

I want to ask one last question about natural gas, and this relates to the imports that we receive from Canada. As we've looked at development of Alaska's natural gas, we've been working with our Canadian neighbors and talking about the Mackenzie Line.

We've never viewed them as competing projects, but really projects that are very necessary for all.

Your report indicates that you're anticipating that the Mackenzie Delta Line comes online in 2012. As you know, they too have experienced some delays, and I don't know whether that 2012 prediction is still accurate. What I'm hearing is that it probably is not. What does that do to the level of imports here in this country? I understand that most of that Mackenzie gas would go into the Alberta area and for domestic consumption. But, does it have a ripple effect into the lower 48 States as well?

Mr. CARUSO. It definitely would. We've pushed that—as you noted—pushed that back 1 year, for every year I've been Administrator. No connection.

But they are somewhat similar issues to what you've been having in Alaska. We do assume that Mackenzie Delta gas would be needed to meet domestic demand for Canada, particularly for processing of the heavy oils, for heavy sands. The longer it's delayed, it will have some effect on the pipeline gas available for delivery to the United States.

Senator MURKOWSKI. So, does that then impact the LNG that we're bringing in to our coastal communities?

Mr. CARUSO. Definitely. I think I said, in an answer to a previous question, to the extent that either Alaskan gas is delayed or unavailable for whatever reasons, and similarly for Canadian gas, any pipeline gas that's not available will have two effects. One, it will certainly raise the price of gas to all of our consumers, and, second, it would require more LNG, maybe not on a Btu-for-Btu basis, but close to that.

As a side note, I'm going to be in Calgary on Sunday, and meeting with Canadian industry and Government officials, so I'll have the latest estimate of when that Mackenzie Delta line might be available, probably early next week.

Senator MURKOWSKI. Good, maybe we'll check in with you.

Mr. CARUSO. I'd be happy to provide that.

[The information follows:]

The latest annual projections from the Energy Information Administration and the most recent information from the National Energy Board of Canada project a start date of 2012. However, recent statements from Imperial Oil, Ltd., (one of the consortium of producers involved in the project) indicate that their earliest start date has been delayed until 2014. The announced change in the schedule corresponds to significant increases in the project cost estimate and the belief that Federal support, in the form of royalties and tax incentives, is necessary for the project to be viable.

Senator MURKOWSKI. Mr. Chairman, I've focused most of my questions on the natural gas situation. We know in Alaska we've got a great deal to offer the rest of the country, but I think it just goes to show that the delays that we experience up North have profound repercussions, in terms of supply around this country. So, I look forward to working with you on ways that we can't speed that along. Thank you.

The CHAIRMAN. Thank you very much.

Let me just ask one or two other questions, and then we'll let you go on about your business here.

There's a lot of discussion around the Congress every time we discuss energy efficiency about, "Where is the low hanging fruit?"

That's the metaphor that everyone likes to trot out. You know, where are the areas that we could change our behavior or our policy, and achieve substantial savings or reductions in energy use?

The Mackenzie Global Institute came out with their recent report, you reference that in your report. Where they said that there are a lot of opportunities to cut the growth in annual global energy demand—and they project it could be cut from 2.2 percent annual increase to a 2.6 percent annual increase, as I understand their report—they talk about residential use, industrial use, power generation, various areas. Have you done a similar analysis as to where the opportunities are for us to substantially improve energy efficiency, or reduction in energy use? Or could you do that kind of analysis? Or could you give us a reaction to the Mackenzie Report's analysis in that regard?

Mr. CARUSO. Yes, we have met with the Mackenzie people and we're looking in more detail at that report.

But what we do do, on a sectoral basis, is look at best available technology. In this outlook, which is not static when it comes to technology or efficiency change, we assume a continued rate of improvement, of utilization of energy, on a sector-by-sector basis based on the track record of the last 20 years.

We also look at what our best available technologies are, and where the gap is largest. Clearly, it's largest in the residential sector, when you look just at best available technology and how much is actually being taken up. There's a substantial amount, percentage-wise, of improvement available in the residential sector.

It's lesser so—but to some extent true—in the commercial sector, although, given the incentives of businesses, they try to utilize the best technologies. An area where there probably is the closest match between best available technology and what's actually being taken up is the industrial sector, because there's so much at stake for these different industries to maintain competitiveness.

Then, finally, if you're looking for biggest impact—clearly it's transportation, where there is such a large share of our total use of energy. So, if you're looking for where the impact can be the greatest, I think the transportation sector is the one. We've done work on this and I'd be happy to share it in more detail with you, but that is the general snapshot.

The CHAIRMAN. So, your assessment of current available technology leads you to conclude that the greatest potential energy savings are in the transportation sector?

Mr. CARUSO. Volumetrically, yes.

The CHAIRMAN. Right, okay. That's helpful.

Let me ask about one other subject. I don't know if your study really tells us much about this or not, but the President has asked that we increase the strategic petroleum reserve, double it by 2027. Frankly, I have trouble understanding how that gives us an advantage to any substantial extent. I'm not clear when we're going to use the strategic petroleum reserve. I'm not sure what adding those additional barrels of oil to the strategic petroleum reserve would do to the pressure on the price of oil. There are just a lot of questions in my mind.

Does anything in your report, anything that you've done by way of analysis give us some insight into the advisability of that, or the

benefits to be achieved from that, or the potential consequences of doing that?

Mr. CARUSO. No, there is nothing in this report or anything that we've done in recent years that's publicly available.

Clearly, with respect to the value of going from, let's say, 700 million to 1 billion barrels, that relies heavily on your assessment of the risk. I remember having been involved in studies looking at the size of the SPR. The probability you assign to a large disruption with long duration has to get relatively high, using the models that we use, to give you a significant benefit relative to the cost. We don't have anything that's been done very recently on that.

In terms of the impact on the market—it really depends, of course, on the fill rate and over what time. As I understand it now, they're talking about relatively low levels of fill over a relatively long period of time. So I would anticipate that that would not have any significant impact on the oil market.

The CHAIRMAN. Well, thank you very much, it's been very interesting, and we appreciate your good work, and we'll continue to have more questions for you.

Thank you.

Mr. CARUSO. Thank you.

[Whereupon, at 11:04 a.m., the hearing was adjourned.]

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