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Economic, Environmental and Security Risks

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Friday, March 5, 2004

PANEL 1:
GLOBAL ENERGY DEMAND 2004-2050

Moderator:

Chris DeMuth, President, AEI.

Panelist 1-Scenarios for Global Consumption

Guy Caruso, Administrator Energy Information Administration

Panelist 2-Emerging Distribution of Energy Supply

John Felmy, Senior Economist, American Petroleum Institute

THIS IS AN UNCORRECTED TRANSCRIPT.

MR. DeMUTH: The next session is going to build on Dan and Bill's initial talks and provide background for the coming policy and security discussions by going into further detail on future patterns of energy consumption and supply, with a particular emphasis on technology.

The presenters are Guy Caruso of the Energy Information Administration and John Felmy of the American Petroleum Institute, fresh from their starring roles on CBS News last night where they were concerned with rather shorter-range and more specific energy questions than they will be addressing this morning.

Guy Caruso has a long and distinguished career in Federal Government service. He was a senior international energy economist at the CIA and has been for many years at the Department of Energy. President Bush named him the Administrator of the Energy Information Administration in February of 2002.

He has also directed important energy security study projects for the Center for Strategic and International Studies and for the United States Energy Association.

John Felmy began his involvement in the energy sector as a laborer and side-room helper on the Tidewater oil pipeline, the world's first oil pipeline, in Pennsylvania. After a few years of that, he decided he would prefer a desk job into the business and so pursued a college degree and his doctorate in economics at the University of Maryland.

He has held a variety of consulting positions in energy economics. He has been at the American Petroleum Institute for 6 years and has for several years now been the API's chief economist and director of policy analysis and statistics.

We will start with Guy and then go onto John, both our PowerPoint guys. I am going to sit out in the audience, so I can watch the show. After both presentations, the three of us will sit up on stage, have a little conversation among ourselves, and then move to questions and a general discussion.

Guy?

DR. CARUSO: Thank you, Chris, and I thank AEI and Brookings for this invitation at this very important conference. I couldn't help but think as Dan was listing his nine factors how important it is to think in the longer term.

For example, this session is, I think, entitled the outlook to 2050. So John Felmy and I got together, and I decided I would do the part to 2025 and John would do the part after 2025.

Right, John?

[Laughter.]

DR. CARUSO: You can't get fired for stuff that far out.

Yesterday, there was testimony before Senate Energy on what was supposed to be the long-term outlook to 2025, but the key topic was next week's gasoline price. And Mr. Reilly pointed out how gasoline prices in San

Francisco these days are about \$2.30. So it is really, as you know, an important political issue.

This morning, I will try to stick with at least my part of it, our long-term outlook which we publish annually for both the U.S.--the Annual Energy Outlook--and then in the global sense, we also put out an international Energy Outlook which comes out in the springtime. So the numbers you will see on the international side are now almost a year old.

I think the key point--and I think Dan said it well--isn't so much the specific numbers. It is the trends, and I think there is general agreement about that because the actual numbers certainly will turn out to be different because the assumptions are so difficult to really be precise about, certainly projecting GDP growth 25 years or population growth or what is going to happen in China. It will be very different than we think right now.

Nevertheless, I think these macroeconomic modeling approaches are really useful for us to be able to at least think of these energy issues that Mr. Reilly pointed out in his opening remarks and Dan elaborated on with respect to security. We do need that kind of systematic thinking, and I think that is really the way I would like to present these numbers today.

The big picture for the U.S. is, indeed, one of growing import dependency, not only for oil, which is the one that we focus on so much, but as Dan pointed out, growing import dependency on natural gas. And I will talk about that in more detail, but a pretty robust growth in energy over the next 25 years, about a 1.5-percent growth, but with domestic petroleum having peaked in the early '70s.

According to some analysts, the natural gas may have begun a peak of its own, even as we speak. We are a bit more optimistic about that, though. We will discuss that, but nevertheless, we will be importing more natural gas in the form of LNG.

In terms of the fossil fuel components, Dan mentioned that 90-or-so percent of our demand is met by them. This just shows that very clearly. Petroleum continues to be the dominant fuel, about 40 percent of our energy market.

Gas, again, was the fastest-growing component in the last 12 to 14 years. Whether that will continue or not is very much up for grabs now because of the increase in price. We now have a bit slower rate of growth for natural gas than we did even a year ago.

You can see that blue line, which was going up pretty steadily, now kinks down a bit and actually comes back to meet coal. That is one of the consequences of higher natural gas prices that we actually in this referenced case, which means policies are frozen and rules and regulations and legislation as of September last year, which, of course, means no carbon restrictions. This could change dramatically with policy changes.

Other areas of interest when one looks at where is the energy going to come from, in our long-term view, we see nuclear growing in terms of its actual production of electricity, but no new nuclear plants being built under current economics, mainly because the capital cost still remains much higher than even natural gas and coal. And the total life cycle costs, even with \$5 gas,

still does not bring new nukes into play without either a subsidization or a reduction in cost.

The main gainer from the higher natural gas price in the electric sectors, electric power sector, is coal, if you strictly go by the model results.

Then, renewables, which we certainly encourage by tax--in some cases, tax credits--do grow the fastest, but from a very low base and remain somewhere in that 9-percent share level by non-hydro-renewables by 2025.

On the production side, coal continues to be our largest domestic resource and clearly will continue grow and grow even more than we thought a year ago, given higher natural gas prices.

Petroleum has a little bit of an uplift in the early part of this decade because we had found some fairly large new fields in very deep water in the Gulf of Mexico, and that will stem the decline a bit, but then it resumes again by 2010. The others, I have already referred to.

Here is the point. I think the chart illustrates the point that Dan made, and that is that we are using energy more effectively, efficiently, whatever your terminology. He used the term 50 percent of what it--per a unit of GDP is what it is at the time of the Arab oil embargo. This shows that.

We had a very steep decline in the early part of that post-embargo period. It has kind of leveled off now to where we are improving at the rate of about 1.5 percent per year in terms of our use of energy per dollar of GDP. In a \$11-trillion economy, about 7 to 8 percent of that is energy, but that means that with a 3-percent GDP growth projection, which we use, our energy demand growth is 1.5 percent.

Of that 1.5-percent improvement per unit of GDP, our studies-- and I think there are others such as MIT that have looked into how do you disaggregate that improvement between energy efficiency or structural change-- in our view, it is about two-thirds of that improvement in the use of energy per unit of GDP is due to structural change, and that is, we move away from a heavy industry, away from the energy-intensive parts of our economy toward a more service-oriented economy. That accounts for a large part of that change, and about one-third of it is I think what we would call energy efficiency through technological development.

Our long-term outlook assumes that that kind of pace of technological development will continue over the next 25 years, and this is the area where there is a considerable amount of uncertainty, as Dan mentioned. Significant breakthroughs in technology can make major differences in that relationship between energy use and GDP.

It is very difficult to model technological breakthroughs. One can say we are going to continue improving how we use energy or how we produce energy at the same rate we have, and that is a fairly safe assumption. Certainly, it can be a lot faster, or in some sectors, it can be slower. So I think that is the one where if you are looking for what can change a lot, that is the area I would focus on, technology, and I think Dan mentioned that.

Looking at it a little bit more sectorally, the big share of the increase over this forecast is in the transportation sector. As you can see, the blue bar started out in 1970, well below industrial use and by 2025 almost is equal to the industrial use of energy in this country.

That reflects one thing I have already mentioned, the less energy intensive components of our economy and to the well-known love affair with the automobile in this country, and of course, the growing income and the mobility not only have the average car or vehicles per family growing over this period, the vehicle miles traveled per vehicle have also grown. So that has been a major factor, and we see that continuing.

One thing we have seen in recent years--and many of you are very familiar with it--is the actual reduction in the miles-per-gallon average per vehicle due to the shifting preference of our consumer towards SUVs and light trucks. That has made a big difference in the growth of the transportation sector. We do see that slowing down a bit as prices rise and it kind of saturates the market.

In the last, at least, 5 years, efficiency continues to improve in vehicles. However, most of the efficiency has been used up in the desire for higher horsepower per vehicle. So that will, we think, slow down, but nevertheless, it is another area where a major change could occur in the petroleum demand sector because 75 percent of petroleum used in this country is in this transportation sector.

On the world oil scene--

DR. CARUSO: [In progress]--expect the straight line, but for the purposes of modeling it, we use this reference case of about \$25 to \$27 in real terms over the long term, which means we don't really think \$35, West Texas Intermediate, where it is today, or \$36 today will be sustainable. It will come

down, but probably not to as low as what we have experienced in the past, which was an average price over the last 22 years of \$20 to \$22.

However, within that band, we certainly expect volatility because of an industry that is operating, as Dan mentioned, almost at capacity, 80 million barrels a day of production. This month, with only about two of unused capacity, most of that is in Saudi Arabia. Clearly, the expectation is for continued volatility.

The story on domestic reliance or dependence on imports is as well known. Net import is 54 percent last year growing to 70 percent, under these assumptions, the already peaked and declining U.S. domestic oil and the growing demand in the transportation sector for oil. These lead to an outlook where we are consuming 29 million barrels a day and only producing about 11 of all forms of liquids by 2025. So we have imports going from 11 million barrels a day to 20 million barrels a day.

This, again, just shows the point I made earlier that in the petroleum sector, most of that growth is in transportation, 75 percent of that, and within the transportation sector, gasoline. And we do see some increase in the amount of diesel use in vehicles during this period.

The industrial sector grows slightly, and this shows the gasoline versus distillate, being mainly diesel fuel and jet fuel growing steadily. So it is a pretty similar picture that we have seen in the transportation sector and the relationship with gasoline and other liquid fuels.

Here is the gas story that Dan referred to in the U.S., and that is growing demand for gas largely--and you can see the steepness of it from where

that "V" is in the red line, going up through the end of the last decade. Almost exclusively the dash for gas in the electric power sector, 90-percent plus of all the electric power generation added in this country in the '90s was combined-cycle gas turbines, and that is continuing, as Dan mentioned, about 200 gigawatts of new capacity just in the last 4 to 5 years.

That will now slow down because we have overbuilt in the electric sector, and demand isn't keeping pace. We had 23 percent to capacity of electric generation in the last 4 years, and demand has only grown 5 percent. So there is going to be a little bit of a catch-up period, but the other point here is the domestic supply won't keep up with this. We are among the optimists in the resources for gas in this country. We see it continuing to grow. Others think that we are already in an inevitable decline.

The National Petroleum Council published a report in September. It said that where we all agree is that whatever the level of that imports we will require in this country, most of it will be in the form of liquified natural gas in the next decade or two because Canada, which was our main supplier of imports during the '90s, has also run into some decline issues with respect to its western production of gas. Therefore, we don't expect Canadian exports of gas to the U.S. to grow much during this time frame.

So most of the increase as shown in the right chart with the large increase in the green bar and almost nothing in the pipeline from Canada is our best assessment, and that depends very much on some of the issues that Dan pointed out about financing, siting, and the security issue of LNG.

The gas demand side of this equation is shown in the black there, the rapid growth in electric generation as I already mentioned. Because of the higher price of gas that is now in our forecast, that tempers toward the period after 2015 as \$5 gas favors new units being coal-fired because of the economics of that and their existing rules, regulations, and legislation.

The industrial sector still grows fairly steadily, and that is an issue I think of very legitimate analytical concern, and that is, how much of this \$5-per-thousand-cubic-foot-of-gas price will actually cause permanent loss of manufacturing or industrial sector capability in this country by moving offshore.

The National Petroleum Council had a substantial decline in demand as a result of higher prices. Our model doesn't show quite as much of a decline. We have natural gas demand growing from its 23 trillion cubic feet today to 31 in 2025. Others think it won't be that high because of this "demand destruction" factor. I think that is an area where more work needs to be done. We are not certain that even that high price will cause manufacturers to move offshore.

The supply side of this--another way of showing it, the black bottom part of this--shows traditional sources of Gulf of Mexico, Lower 48 conventional gas, conventionally produced gas, is in decline. I think there is almost complete agreement about that. It is just a question of how steep is that decline.

The NPC study says it is steeper than our estimate here. We think that the new supplies of unconventional gas which is gas produced in tight sands, particularly in the Rocky Mountain areas, coalbed methane, and shale gas

will make up a big part of that decline, but, again, we are among the more optimistic about that resource on a resource basis.

The other big domestic supplier is Alaskan gas. There is an abundant supply of gas in the North Slope of Alaska. We believe a pipeline will be built on the strict economics of that gas cost and transportation cost to getting it to the Lower 48.

If it is left to the economics of the market under our model, that gas comes onstream in 2018. The conference energy bill, which was not passed, but debated and continues to be debated, does have some incentives in it that would move that forward as much as 5 years if a price floor were to be included, which is in the latest version being proposed.

But you can see even with a relatively optimistic view of domestic gas, there will need to be substantial growth in LNG imports. They represent 3 percent of our gas supply this year. This outlook has them going to 15 percent. Among others, CERA has even a more bullish view of where LNG will be in the total gas supply by 2025, and a lot depends on where you think some of those other segments shown in this chart will be.

If you are less optimistic about domestic gas and you think we are going to have that much demand, then the only alternative is LNG.

There are two things about the price of natural gas analysis. One is that we think that the \$5-per-thousand-cubic-foot gas mark that we have seen now for almost 2 years, which is about a 70-percent increase, by the way, over 2002, we think that will come down as a result of two things.

One, LNG can be brought into this country at a lower price, at a lower cost than that, and therefore, we will provide some competition. You can see that sharp after getting as high, above 5. Our price comes back down as you get to 2010 with the building of new LNG facilities.

In our model, 9 to 12 new LNG regassification plants coming onstream between 2007 and 2025, there are four existing plants now. It would be inadequate to meet the kind of demand I showed in the previous chart. So they will all be expanded, but will need a number of other new plants. There are some issues there as to whether they will come on in a timely fashion, and that would change that price curve.

The other thing that would change it is the impact of technology on developing the existing resource base of gas in this country. A more rapid improvement in technology would probably mean lower prices. A slower technology would mean higher prices, but in any case, we see natural gas prices increasing, again, after that 2010, the dip-down period toward 2010. So it goes down and then back up again.

Now let me just quickly put this in the context of the world. On the world side, our view is that we have got rapid growth in energy consumption on a global basis, and to reiterate Dan's point, much of it is in the developing world, much of which is in developing Asia, about a 60-percent growth in total in energy demand on a world basis. Again, much of that is in the fossil fuels, as natural gas is also the favorite fuel in many of the developing countries as they move towards further electrification, but oil in the transportation sector--and Dan mentioned China--where is it going to come from on the security side?

The demand is largely in the developing countries, and we see OPEC growing in its importance in our outlook.

Dan mentioned 10-million-barrel-a-day growth, CERA's outlook for OPEC demand in the next 20 years. We would see at least that in the next 10 years and even more by 2025 with OPEC, I think, in this outlook, about something like 50 million barrels a day out of a total world demand of over 115. That is because, as Dan mentioned, that is where the reserves are, as this chart shows.

The only point on gas in this is that it is not only the U.S. that has made natural gas the fuel of choice. It is many of our friends and allies in OECD and of growing importance in the developing country.

Where are the reserves? The major reserve countries on gas are Iran, Russia, Middle East, and former Soviet Union. The LNG will come from those countries, plus others such as Algeria, Venezuela, Nigeria, and Trinidad.

Mr. Reilly pointed out the critical importance of the relationship between energy and environment, and this kind of outlook with such dominance of fossil fuels means growing carbon emissions. That, of course, is an important issue not only for today's discussions, but for looking at policy questions and dealing with the issues that Dan raised and I think John and I will raise by our fundamental. So I think the summary is fairly clear. I think this will be available to everyone. So I don't have to repeat this.

I know I have taken a little more time than I thought. So thank you, once again, for your attention and, Chris, for your invitation.

[Applause.]

DR. FELMY: Good morning, everyone. Thank you very much for the opportunity to present some of API's views on energy policy. This is a very important event.

The National Commission on Energy Policy is an important organization, and I laud them for moving forward in a very balanced way in terms of developing an energy policy that we think is important and will help American consumers.

Let me start by saying, first of all, I want to thank you for inviting me to speak on something other than gasoline prices.

As Guy mentioned, the price of gasoline in California and Nevada hit records yesterday, were a couple cents away from a record for national averages, and so the number of phone calls that I get on an average increases pretty dramatically right now. So I am happy not to speak to that issue.

What I will do is, first of all, just reiterate some points that both Guy and Dan have made. They pretty much covered most of my slides. So what I will focus on is the policy issues, the concerns that we have, and I will also talk to a couple of what I consider important points, such as climate and regulatory issues that I think are important, as we move forward with developing a rational energy policy.

I put this title up because virtually, once a week, I get a call from some reporter saying, "When are we running out of oil?," and it is usually from some conference or other around the world. My answer as an economist is, firmly, "Never." It is a question of what the price will be.

So, going forward, let's look at where we stand, first of all, in terms of the energy situation, and this is pretty much the same data that Guy has put up, but I have reconfigured it a little bit.

This shows the shares of energy currently used in the U.S. right now, where the dominant share is petroleum. It is going to continue to be that way. Natural gas is second, and it is a fairly constant share over the next 25 years, the same with coal and nuclear.

Renewables continue to be a small share of the total energy supplies, and that is important--and I will break this out in a little more detail--and that is because of their cost. Until we reduce the cost of renewable energy, they are going to continue to play a smaller role and, indeed, a niche role, but an important role.

If we break out renewable energy itself, these are the components that you have in terms of renewables. Unfortunately, I notice that hydropower, which is the largest, the 2.85 percent--dropped off of my Excel spreadsheet. So, at the bottom, you can imagine 2.85 percent.

But if you take a look, hydro is the largest of renewables, followed by wood and waste, both residential and commercial. We have got a large amount of municipal solid waste, MSW.

Ethanol is projected to grow significantly, whether or not we adopt the renewables fuel standards or even just under current policy.

Then, if you look at the darlings of renewable energy, which is wind, solar, and geothermal, those other ones, for the most part, with the exception of ethanol, very few people are advocating increasing dramatically,

not big dams, not a large expansion of wood, but if you look at the sources of renewables that everybody thinks of, you are talking about less than 0.5 percent of our energy.

So, even if you increase that energy source by a thousand percent, you get to 5 percent. So renewables will continue to be a small role until we develop the technology to be able to reduce the cost, and so that is an important message that we have got to look at going forward.

If you look at EIA's forecast by 2025, you can see that, indeed, they do grow as a share, as you can see from the previous two slides, but they still remain a small share. This is about a 52-percent increase over 2025.

So an important point of energy policy has to be we have to take this reality into account. Otherwise, we are being disingenuous with the American public in terms of what can actually supply secure sources of energy, cost-effective and reliable and affordable energy.

Now, this is the world energy consumption chart that is similar to those pie charts that they had, but I just also discovered that I have "2020" instead of "2025," but you can see the message is here. Both for the world and for the U.S., you have the predominant share of energy is going to be supplied by petroleum, natural gas, coal, nuclear, and then you have an important role for renewables as you go forward in terms of what they can play in the world's supply of energy.

This is a slide courtesy of Exxon Mobile that breaks out these sources in a little different way, so that you can see how the conventional sources of energy stack up over the next, therefore, accounts for 2020, and how

you see even significant increases in energy for wind and solar, they still remain a small share of energy.

That is important because, for the world outside the U.S., renewables can, indeed, play a very important role, especially if you have areas that are off the grid because the cost of building the grid there would certainly be prohibitive. So renewable sources of energy can play a very important role.

Indeed, in the U.S., renewables can play an important role if we get the prices right. My favorite example is in the case of solar. If you have peak-load pricing, time-of-day pricing, it makes solar much more attractive.

In other words, for example, in Montgomery County, where I live, I pay about 25 cents a kilowatt at peak. Well, as the cost of solar comes down, that makes it fairly competitive at some point, probably in the not-too-distant future. So it is the combination of those things that are going to be important in terms of how we look at what our energy policy should be.

Where is the source of demand? This is pretty much consistent with what Guy has put up, where you see strong increases in demand outside of the OECD, the rest of the world, Latin America, Asia Pacific, and most of that demand is going to be for transport. That is because, as was mentioned, 4 million new cars being sold in China will generate a lot more demand for petroleum products as a result of that.

So we have got this that virtually everyone agrees with in terms of where the demand is going to be. It also means we are going to have a massive amount of supply growth needed.

Going forward, it is going to have to be a lot from OPEC, a lot from non-OPEC sources, and so what we are going to see is kind of a separation between where the demand growth is versus where the supply growth is, and that is characterized by this, where you can see the United States as a net importer of energy.

Right now, we import 55 to 60 percent of our petroleum, 15 percent of our gas, a couple percent of electricity, and that is going to all grow. From 26 to 30 percent of our supplies will be imported, but we have got large sources of energy, both oil and natural gas--and this is just for oil--concentrated in like the former Soviet Union and Eastern Europe and, of course, in the Middle East for both oil and gas.

So what that creates is this logistical issue of getting secure sources of supply moved from where they are produced to where they are consumed, and that is going to be a challenge.

So now what do we recommend in terms of going forward? Well, briefly, I am going to say that economy will play a very, very important role. We can expect it to change dramatically. Just the technological development that we have had in, for example, deep-water drilling over the last decade is incredible in terms of being able to find 10 billion barrels of oil in the Gulf that we didn't know existed before. So we will be able to develop new technology for production and new technology for consumption.

Consistent with the NCP's principles, we believe in markets, that they should play a fundamental role in terms of flexibility and in terms of efficiency in market discipline.

We also believe as part of that, that oil is going to continue for a while as the main source of energy, no matter what you think. As was mentioned, they probably talked about running out of oil since 1859.

One of the favorite quotes I have was in 1874, a geologist from Pennsylvania said we were going to run out in 10 years, and that was just using it for kerosene, without even motor gasoline.

So, over the last 150-odd years, we found more oil than we consumed. We build our reserves up continually. So is the end of oil in sight? Not now. At some point in the future, it is entirely possible that we will see complete declines through exploration and so on, but at this point, oil will continue to play a very important role for the foreseeable future. So we shouldn't try to phase it out earlier than makes sense as long as we need it.

Finally, running out, as I said, is not likely. Now, there has been quite a bit of controversy over the past couple of months over running out of oil. There was an announcement by one company in terms of reserve changes, which precipitated a whole lot of questions about, well, is the oil really there, and the answer is yes, it is still there.

There are some accounting issues and so on, but the oil is still there. Then, that was followed by the debate between Matt Simmons and Aramco in terms of is it a Saudi source of oil supply coming in that is going to be running out.

In terms of looking at the debate that went on between those two folks, I would say that Matt puts together a very powerful statement. He has done a tremendous job in assembling a lot of data and so on, but if I compare

what his statements are versus what the Aramco folks have put together, on a balance I would say the evidence supports them. So we are not running out of oil in the near future, but we do need to think about what our resource needs are going to be going forward.

In terms of developing additional supply, as I mentioned, we are going to need a lot more no-OPEC supplies, but those are moving into challenging frontier areas, such as Kazakhstan and so on, deep water where we are drilling in thousands of feet of water.

Gulf OPEC, as Guy mentioned needs to increase, basically double their capacity to be able to meet those needs, and the capital needs are enormous, not "enormous."

[Laughter.]

DR. FELMY: When you do these things at night, spell-check doesn't always work, anyway. Spell-check is, I think, a tool of the devil because you can get yourself in a lot of trouble with it, anyway. But I didn't use it there.

So, anyway, looking at the IEA's projections of demand for capital investment, we are talking about trillions of dollars that is going to be needed to bring all sources of energy supply going forward for consumers.

To get this, we need policies that promote free investment and trade. That is essential. We don't need the types of policies that restrict activities across borders.

We need to really make an accurate depiction of resource development. There is a lot of information that floats around that says uniform-ly resource development for countries is bad. We know that is not true.

Certainly, there have been problems, but we know that there are benefits from it, and we have got to have a realistic assessment of what it will be.

We have got to reconcile the notion that a lot of folks are opposed to these types of developments everywhere. They fit in, in the United States. They fit in the world, but development against some of these resources will continue to be opposed.

I will close in terms of overall policy looking forward for long-term energy supplies. Just as in the movie, "The Graduate," I think the statement--but I couldn't check it last night because my Internet connection crashed, but it was "I have one word for you, young man: plastics." Well, I have one word for you, hydrates.

Methane hydrates are potentially the resource of the next millennium. If you look in the United States alone, the USGS estimates that we have 320-thousand-trillion cubic feet of methane hydrates in the United States in terms of undiscovered deposits, but we don't have the technology available to develop them yet.

But if you take a look in terms of fossil fuels in the United States, we consume about 80-trillion-feet equivalent of natural gas of hydrates. So this is potentially a resource that is 4,000 years of energy, a millennia of energy. So that is the long-term thing, but now let me turn to the major elephant in the room in terms of what is going on with policy, and it is climate change.

In my opinion as an economist and I think based on studying solar activity for the last 18 years, the climate science has clearly not settled.

From an economist's perspective, it means that when you have two series moving together like this, you have got your data and you really can't explain or attribute in a statistical sense a share of impact from one versus the other. So it is clear the science of climate is not settled, but the economic impacts of some policies like Kyoto and potentially McCain-Lieberman policies are, and they are extremely negative for the U.S. economy or the world economies.

So, on balance, we recommend that going forward, even if the science is not settled, it is not an excuse for inaction. In fact, our industry is focusing very much on reducing our emissions and improving our technology and dramatically improving our efficiency in those areas. That is what we should be doing, but just as if the science isn't certain, it is also not an excuse for doing bad policies. So we need to look at that.

Finally, the last thing I will address is regulatory policy. As was mentioned in gasoline markets, this is a case of regulatory policy run amuck.

We have 18 different types of gasoline in the United States, and many of the problems in California right now are attributed to the unique type of fuels that they have there that aren't used anywhere else. So, as we go forward in terms of developing an energy policy, we need to be conscious of unintended consequences because this clearly is a case where layers of Federal policy, State policy, and local policy have created what is simply a mess of gasoline regulations that really accentuates the boom and bust that we have had in those prices for the last 4 years.

So, with that, I will close and thank you, and I will be happy to answer any questions later.

[Applause.]

MR. DeMUTH: We have just a couple of minutes. So what I want to do is see if, Guy and John, you have any remarks to make on each other's presentations. Otherwise, I am going to move immediately to questions and comments from the group.

DR. FELMY: Well, since I used Guy's statistics, I am not going to criticize them.

DR. CARUSO: John raised hydrates, and our geologists are very optimistic about hydrates in the post-2030 world. It is an enormous resource.

MR. DeMUTH: Okay. Yes, sir. Please wait for the microphone, introduce yourself briefly, and then ask your question.

MR. : Yes. My name is Gru Swami, Energy Environment Security Initiative in Colorado.

I hadn't heard anything about hydrogen. Is that a resounding vote of confidence on the hydrogen policy of the administration?

DR. CARUSO: Our model, as I pointed out, assumes existing policies, rules, regulations, and programs as of September of last year when we did the latest long-term outlook.

Based on what was in place then and the kind of programs that are available now, the model does not see any significant amount of hydrogen penetration to the energy economy by 2025.

MR. DeMUTH: John?

DR. FELMY: Our companies are all working hard on hydrogen fuel cells-type issues.

The issue with hydrogen is going to be how do you get it there, how do you manufacture it, how do you deliver it to consumers, and my personal opinion is that it is going to be a competition between the pure forms of hydrogen and some type of hydrocarbon which uses an on-board reformer to be able to power-generate the hydrogen on board and then power the fuel cell.

That is a significant advantage in that the infrastructure to deliver that product is already in place. We have got 167-or-so gasoline stations, pipelines, things like that to deliver the hydrocarbon or perhaps natural gas as an alternative, and then you can reform it on board.

We would have to make a massive infrastructure investment in pure hydrogen pipelines or transportation devices and so on, but it is a tremendous opportunity in terms of reduced emissions and efficiency.

MR. DeMUTH: Yes, sir. This gentleman here.

MR. : Following up on that last question, we have technologies in existence today which are under improvement, certainly within a few years. We could have advanced diesel engines which are now getting 50, 55, 60, on the highway, miles per gallon. In conjunction with a hybrid electric drive train, we could see cars getting 100 to 120 miles per gallon, conceivably, but American society has not been willing, either individually in the marketplace or collectively through the political process, to pay the cost of that, which would be 10- to \$20,000 incremental cost of the vehicle, a good deal of which would be recovered in fuel savings over the life of the vehicle.

That being the case, what reason do we have to believe that Americans are going to be willing to pay the \$100,000 or so that hydrogen fuel cell vehicle prices may get down to, if they work at all, and isn't this whole notion that there is going to be a hydrogen economy 10 or 15 years from now, isn't that a decoy? Isn't that counterproductive to making real progress in energy policy in the interim?

DR. FELMY: Well, my perspective on that is clearly the diesel hybrid technology could play a very important role.

The efficiency in terms of well to wheels for that technology can be virtually identical to the optimal hydrogen fuel cell drive on that, but both need technological development.

I am not an automotive engineer to be qualified to say it is 20 years from now or 30 years from now, but I will say that it is important that the promotion of these types of technologies not be biased in any sense, that it is the marketplace that plays the role.

DR. CARUSO: We have some penetration of the advanced technology, diesel engine, in our outlook, but it is relatively small, largely because of consumer preference, as you indicated.

On the hydrogen, if I could step out of my EIA role, I think the DOE's view is that that is an appropriate role for a government to get into, in this case, hydrogen when it is basic research and development, to try to move it along towards a commercialization.

It is clear that we have a long, long way to go to bring that cost down, which is why I said there is no hydrogen in our 2025 forecast strictly because of the economics that you referred to.

MR. DeMUTH: Reed?

MR. : I am Reed Detchen [ph] with the Energy Future Coalition. I have a question for John Felmy.

Given that you foresee, and I think everybody foresees, continued increases in demand for oil--and in fact, the bigger problem is meeting the demand--setting aside sort of macroeconomic concerns, why would it be a concern to the oil industry or the oil and gas industry whether or not there is some sort of financial penalty placed on carbon? It seems that that might dampen demand in a way that would make it easier for you to respond to it.

DR. FELMY: Well, it is fundamental economics.

Imposing mandates such as restricting carbon, when I feel that they are not justified in terms of--based on sound science, it is an extremely negative--it will impose extreme negative impacts on the economy from a broad sense.

MR. : But in terms of the oil and gas industry itself, what would be the negative impacts?

DR. FELMY: Well, of course, if you impose carbon controls on all energy, then petroleum demand will suffer because you are raising the relative prices of that because of these others, other lower carbon fuels.

MR. : And how would that work in transportation?

DR. FELMY: Well, it would raise the cost, which, of course, will affect the demand, irrespective of competition. It could promote natural gas vehicles as an alternative to it, which from our industry's perspective is fine because we produce both oil and gas.

MR. : So what is the problem?

DR. FELMY: Well, the problem is that it is bad policy from an economic policy. It is not justified.

MR. : But from the oil and gas industry's perspective, financial economic perspective, what is the problem?

DR. FELMY: Well, the problem is that it is bad overall economic policy, and we as an industry are not going to embrace a bad economic policy, irrespective of the individual impacts on our industry.

MR. DeMUTH: Guy, do you want to give the administration's position on a carbon tax?

DR. CARUSO: We are against it.

[Laughter.]

MR. DeMUTH: This gentleman right here.

MR. HOLDREN: I am John Holdren. I am going to get my chance this afternoon, but I am afraid that the same people might not be in the room, and in particular, I am worried that Dr. Felmy might not be in the room.

DR. FELMY: I'm sorry. I won't be.

MR. HOLDREN: So I want to make an observation on his solar theory of climate change, which is that your theory is not sound science.

When you look at the correlation between solar output and temperature change, you have to be worried not only about the trend, but you have to look at the amplitude, and the amplitude of the solar change is not remotely sufficient to account for the observations.

Basically, the magnitude of the solar forcing, by the best estimates of the scientific community, are five times smaller than the magnitude of the CO2 forcing and 10 times smaller than the magnitude of greenhouse gases and absorbing particles altogether. So it just ain't remotely there. That is why the National Academy of Sciences rejects your view. That is why the Intergovernmental Panel on Climate Change rejects your view. That is why the American Geophysical Union rejects your view.

I will be more interested in your views on what is driving climate cycles when you get more interested in my views on what drive economic cycles.

Thank you.

[Applause.]

MR. DeMUTH: John?

DR. FELMY: I respect your opinion on that, but what we also say is that 20 years ago, nobody felt that solar had any impact at all. Now that is dramatically different. It has increased significantly as a result of scientists finally acknowledging--acknowledging what they don't know or understand, and that is an important component.

If you look at those trends, you have got to acknowledge what we don't know. I am not saying the science one way or the other. I am just saying

there is sufficient doubt in that over hundreds of years to show that there is a correlation there.

MR. HOLDREN: I wish you were going to be here this afternoon.

DR. FELMY: I would love to, but I can't.

MR. DeMUTH: We have time for one more question, and then we are going to conclude this panel.

Well, this gentleman has already asked a question, so behind him.

MR. : Hi. I am Paul Lottner [ph] from American University. A follow-up question, really.

What would it take for skeptics of climate change to open to another position? The Intergovernmental Panel on Climate Change, the National Academy of Sciences and so forth, what we have heard--what would it take--what is the kind of evidence as you weigh this out? As long as, it seems to me, the science of climate change is a black hole, it is infinitely complex and so forth, and there is always going to be some scientific uncertainty, but what is the level of confidence that someone like you or the industry would accept to shift their perception on this issue?

DR. FELMY: Personally, I have looked at all of these documents. We have reviewed them, and we find deep flaws.

If you look at the whole explanation that I have seen, that, oh, well, you know, solar impacted the first half of the century, but it really didn't have a big impact on the second half of the century, if you look at my charts,

you don't see anything like that. So I don't know how they come to that conclusion.

Fundamentally, the issue of uncertainty is important in that it means you need to be cautious. It means that you need to do things that makes sense, which is reducing emissions, improving technology, and moving forward, and that is what the industry is doing.

We have made massive efforts in terms of quantifying our emissions, in terms of reducing our emissions, in terms of improving our efficiency, and that is what one should do that is prudent.

On the other side, if there is an uncertainty, it is not an excuse for doing something that is bad economic policy, and that is my point in this, not whether or not you will ever accept the certainty of the science or whatever.

You could just as easily have seen solar activity turn down over the next century, and we would be moving into an ice age. Well, then, if you would have adopted policies which would have destroyed our energy system, you would have done the wrong policy. So the key thing is to use caution going forward in terms of what is the justification for doing activities that make sense and not doing activities that don't make sense.

MR. DeMUTH: We are going to take a break of 8 to 10 minutes for coffee and stretching our legs.

The next session which is on energy geopolitics will be chaired by James Steinberg, director of Foreign Policy Studies at Brookings.

We will reconvene a minute or two after 10:30. Thank you very much.