Congressman Roscoe Bartlett
Joined by Congressman Wayne Gilchrest
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PEAK OIL PRODUCTION AND GLOBAL WARMING (Part I)
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@20:45 (8:45 PM) Eastern

The SPEAKER pro tempore (Mr. *Hall* of New York). The gentleman from Maryland (Mr. *Bartlett*) is recognized for 60 minutes.

Mr. BARTLETT of Maryland. Mr. Speaker, tomorrow we vote here in the House on an energy bill. And I thought it might be appropriate to spend a bit of time this evening looking at where we and the world are relative to energy. I have here a chart with some numbers on it that inspired 30 of our prominent Americans, Jim Woolsey, Boyden Gray, McFarland and 27 others, among them retired four star admirals and generals, to write to the President a letter which said, ``Mr. President, we have only 2 percent of the world's oil reserves. We consume 25 percent of the world's oil, almost two-thirds of which we import. And that presents a totally unacceptable national security risk. We really have to do something about that to free ourselves from the necessity of buying foreign oil.''

The President recognizes that this is a problem. In his recent State of the Union message he said that we are hooked on oil.

There are a couple of other interesting numbers here. We represent actually a bit less than 5 percent of the world's population. We represent about one person in 22 in the world. And with only 2 percent of the world's oil reserves, we are pumping 8 percent of the world's oil. What that means, of course, is that we are pumping our oil four times faster than the rest of the world. We have been pumping less oil each year now for several years, and with this high pumping rate that decline will accelerate.

How did we get here? To find how we got here, you have really got to go back about 6 decades. I didn't know last year on the 14th day of March, when I gave the first speech here on the floor about peak oil, that I was just 6 days beyond the 50th anniversary of what I think will come to be seen as the most important speech given in the last century. This was a speech given by M. King Hubbert, a Shell Oil company geologist, to a group of oil people in San Antonio, Texas. At that time, if you look back in your history books, you will see that we were the largest producer of oil in the world. We were the largest consumer of oil in the world, and we were the largest exporter of oil in the world.

And M. King Hubbert shocked his audience by telling them that in just about a decade and a half, roughly 1970, the United States would peak in oil production. And no matter what we did after that, our production of oil would decline.

I have here a curve which shows his prediction. His prediction is the small green symbols here, and the actual data points are the larger green symbols. And you see they reasonably followed his predicted curve. By 1980, when Ronald Reagan took office, we were already well down the other side of Hubbert's peak, and we knew very well that M. King Hubbert had been right about the United States.

Now, in 1969, M. King Hubbert predicted that the world would follow the United States in peaking in oil production about now. If he was right about the United States, why shouldn't he be right about the world?

It has now been 27 years since we knew, in 1980. We are already 10 years down the other side of what is called Hubbert's peak. And we knew that he was right about the United States and he had predicted that the world would be peaking about now.

If he was right about the United States, why shouldn't he be right about the world? And shouldn't we have been doing something about anticipating this world peaking oil production?

The red symbols there, by the way, are a similar curve for the former Soviet Union, now today, Russia. And you see that when they fell apart they did not meet their expectation, so they are now having a second little peak, but they will follow the general downward trend.

How was M. King Hubbert able to predict this? We had already been producing oil for quite a while in 1956, and M. King Hubbert had watched the exploitation and exhaustion of some individual oil fields, and he found that they always followed what we call a bell curve. Small production at first, and then increasing and finally reaching a maximum, and then falling off the other side.

This bell curve is very familiar. If you weigh people, some will be very light and some will be very heavy, but most of them are somewhere in the middle and they follow a bell curve. If you measure the heights of people, they will follow a similar curve, or the number of mice in a mouse's litter. There are just a great many things that follow this kind of a curve.

So he noted two things, one, that most of the fields tended to be exploited and exhausted in a bell curve, and when they had reached a maximum, for the average field, half of the oil had been pumped. And so he rationalized that if he knew how many fields the United States had, and how many more we would discover, if he added up all the little bell curves he would have one big bell curve which would indicate when the United States would peak in oil production.

He did that. His math may be difficult to follow, but his reasoning is pretty simple. He did that, and he predicted it would be 1970. And right on schedule, we peaked in 1970.

I have been joined on the floor by my good friend, also from Maryland, *Wayne Gilchrest*. And before I yield to him, I would just like to introduce what he is going to talk about by quoting here from the International Energy Agency. This is a recent press release. And what they say here, ``The energy future we are facing today, based on projections of current trends, is dirty, insecure and expensive. But it also shows how new government policies can create an alternative energy future which is clean, clever and competitive.''

They go on to say that ``energy demand increases by 53 percent between now and 2030.'' Well, it may. The demand may increase by 53 percent, but the use will not increase by 53 percent because, as you will see when we develop the subject this evening, the oil almost certainly will not be there to meet this demand.

Over 70 percent of this increase comes from developing countries led by China and India. World oil demand reaches 116 million barrels per day in 2030, up from 84 million barrels today in 2005 and 2006 and 2007. That number really hasn't changed. We have been on a plateau for the last 3 years of about 84, 85 million barrels of oil per day.

By the way, we use about 21 million barrels a day, about exactly one-fourth of that. Most of the increase in oil supply is met by a small number of major OPEC producers. Non-OPEC conventional crude oil output peaks, they say, by the middle of the next decade. Most observers believe that that has now peaked and, as a matter of fact, the world is about to peak. These trends would accentuate consuming nations' vulnerabilities to a severe supply disruption and resulting price shocks. They would also amplify the magnitude of global climate change.

Mr. *Gilchrest*, I am pleased to yield to you. They introduce the subject that I know you are very much concerned about, and that is what our increased use of fossil fuels is doing to our climate and how it is affecting global climate change and global warming.

Mr. GILCHREST. I have sort of a summary, I guess you could say, a Global Warming 101 Introductory, which will take about 10 minutes, so I am not sure how you want to proceed. Do you want me to just give this sort of a 10-minute introduction to global warming, or break it up with your dialogue?

Mr. BARTLETT of Maryland. I think that would be very instructive for our audience. Please do.

Mr. GILCHREST. Congressman *Bartlett* is talking about peak oil, the idea that our energy from oil is a finite resource, it is limited. And what I would like to do, in conjunction with that, is to give a perspective on one of the legacies of the age of oil, and that is global warming, heating the planet, upsetting that delicate balance between what the Earth has been used to for thousands of years, and the natural range of fluctuation in the climate, to what we have done in less than 100 years as a result of burning fossil fuel, oil in particular.

So here is how I would like to proceed. Number one, the Earth has a livable climate. The biosphere, which is the area of the planet that contains life forms that we have become familiar with is possible because of something called the greenhouse effect.

Now, in our atmosphere, we have oxygen, water vapor, methane, carbon dioxide, a number of different chemical mixes which provide us with the air we breathe and the type of atmosphere that produces, in part, the climate that we have, hence the greenhouse effect. It is warm enough and cool enough for life, as we know it, to exist.

Now, one of the most important greenhouse gases, other than water vapor, other than oxygen, other than methane--all of these contribute to the greenhouse effect--is carbon dioxide, or CO2**.**

Now, even though carbon dioxide is less than 1 percent of the makeup of our atmosphere, it is critical in the heat balance of our planet. Now, that sort of gives us an idea of the importance of these greenhouse gases and the importance of carbon dioxide.

Now, is the Earth warming? There is no question, everybody would say yes, the Earth is warming, and it has been warming for the last 10,000 years. It has been warming for the last 10,000 years because that was the end of the Ice Age 10,000 years ago, and sea level has been rising, and the planet has been warming all of that time.

[Time: 21:00]

It is warming, in part, because there is an increase in carbon dioxide in the atmosphere. Ten thousand years ago, and you can evaluate this by looking at ice cores and checking the bubbles out, and see what the content in our atmosphere of CO2 was by looking at those bubbles in ice cores from Greenland or the Antarctic, and CO2 was about 180 parts per million in the atmosphere 10,000 years ago. CO2, a greenhouse effect, or a greenhouse gas, was at 180 parts per million 10,000 years ago.

If we move forward almost 10,000 years to the year 1890, in 1890, CO2 in the atmosphere was 280 parts per million. It took just about 10,000 years for CO2, a greenhouse gas, which helps the balance of Earth's climate, it took almost 10,000 years for it to increase almost 100 parts per million.

Now, let us look at the year 2000. In the year 2000, CO2 was 380 parts per million. In effect, the natural causes before the Industrial Age were really in full swing. The natural causes gradually warmed the planet over 10,000 years very slowly.

What we have seen in the last 100 years, actually, about the last 50 years, is a dramatic increase in the amount of carbon dioxide in the atmosphere, something like we have not seen for hundreds of thousands of years and perhaps millions of years. So CO2 in the atmosphere right now is 380 parts per million. We haven't seen that much CO2 in the atmosphere for 800,000 years. Now, as a result of this, we are going to see some changes in our climate.

Let me make this last comment, though, about CO2 in the atmosphere, about the heat balance, about how the greenhouse gases intermix with the atmosphere. Human activity, burning fossil fuel, has put into the atmosphere in a little more than 50 years what the natural processes took out of the atmosphere, and it took more than millions of years to effect. In less than 100 years we have changed the atmosphere more than the natural processes of the Earth have changed the atmosphere in millions of years.

Now, what are the ramifications of this? Well, warmer seas and warmer temperatures. If we want to associate

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that with hurricanes, we have more frequent, stronger hurricanes as a result of that. Warm seas are fuels for hurricanes.

What is that doing to our economy? What is that doing to our coastal communities? What are some of the other implications?

Well, one other significant implication is sea level rise. If you went to Ocean City 10,000 years ago, and we know Ocean City in Maryland was not there 10,000 years ago, if you went to Ocean City, where Ocean City was supposed to be 10,000 years ago, you would have 75 more miles to go before you got to the ocean; 10,000 years ago you would walk from Alaska to Russia, easily, there was a land bridge, a wide land bridge.

Today we know that you can't. That is because sea level has been rising, and it has been rising because of the natural consequence of global warming, but now there is a significant change. For example, the temperature has increased, sea level temperatures have increased. In the last 20 years we have lost 40 percent of the volume of the Arctic ice. The Arctic ice cap, we have lost 40 percent of the volume of that.

Let us take a look at Greenland. In Greenland, it has 630,000 cubic miles of ice, Greenland, 630,000 cubic miles of ice. If that were all to melt, sea level around the globe would rise 23 feet.

Now, we know that Greenland's ice shelf is melting. Recently it was discovered that it is melting 10 times faster than anybody could have ever anticipated. A few years ago, it was losing about 80 cubic miles of ice a year, a few years ago. Today, just a matter of a few years later, it is losing now, and it is accelerating, 80 cubic miles of ice are melting every year.

When I say melting, it is not dripping. This is running off. In fact, the greatest contributor to fresh water to the world's oceans is not the Nile River, it is not the Amazon River, it is ice melting, pouring off the ice shelf of Greenland.

What is that going to do to our coastal communities, our coastal economies? What happened in Katrina, in Louisiana and Mississippi and Alabama? What is happening in a fairly more frequent occurrence to States like Florida or South Carolina, or even States like ours, the State of Maryland? What other changes might there be?

CO2, carbon dioxide, is being absorbed at an increasing rate by the world's oceans. How will the oceans change as a result of this absorption of CO2? It will become more acidic. The ocean chemistry will actually change in the ocean, and it will become more corrosive. What is the problem with an acidic ocean that is more corrosive? Some of the best habitats in the world for the world's most abundant fisheries are coral reefs. Coral reefs cannot survive in an acidic ocean. A whole host of ocean creatures will be disrupted in their process to reproduce or in their process to exist at all. There will be warmer temperatures in the atmosphere, increased forest fires, increased infestation, increased invasive species, changing in agriculture practices, changing in weather patterns. There would be more significant rain storms, more significant snow storms.

Storm cycles would be difficult to predict, shifting in vegetation zones, habitat lost for a whole range of flora and fauna species and 40 percent of ice lost in the Arctic ice shelf right now, and accelerating, may be gone by this midcentury, a whole range, including polar bears or endangered species.

The coastal economy, the coastal economy in the United States is 50 percent of our GDP, 50 percent of our GDP. The likelihood of sea level rise as a result of all of this is going to be between 1, and more likely, at least 3 feet, that will clean out, wipe out, disturb, destroy most of the coastal cities in the United States on the Atlantic and gulf coast.

We are looking at New York City, Boston, Wilmington, Baltimore, Philadelphia, coastal areas from Maryland down to Florida, including Miami. Much of the peninsula of the State of Florida will be under water, not to mention, if you look at the State of Maryland, much of the peninsula, the Delmarva peninsula.

The natural range of fluctuation has been disrupted by the burning of fossil fuel, by oil, a limited resource, the end of the Oil Age and what are the consequences, the last 100 years of the Industrial Age, the age of fossil fuel, the natural range of fluctuation for CO2, methane gas.

The temperature range in the last 10,000 years has been fairly close and predictable. Now, imagine a straight line, and what does a hockey stick look like? We have corresponded the increase in CO2 with the increase in atmospheric temperature, the increase in land temperature, and the increase in sea level temperature. All of this corresponding to the increase in burning fossil fuel, and as a result, the increase of methane carbon dioxide.

I want to end with a quote from a gentleman called Norman Cousins, who had an illustrious career in journalism and in politics. Norman Cousins says, ``Knowledge is the solvent of danger.'' And the key to the successful understanding and opportunities for a brighter outcome with what Congressman *Bartlett* is talking about as ``peak oil,'' the end of the age of oil, and its consequences in global warming, the key to understanding and finding a solution is knowledge.

Mr. *Bartlett*, thank you very much for the time.

Mr. BARTLETT of Maryland. What the gentleman has been talking about is more than valid reason for pursuing the development of alternatives, if no other. Why would we want to increase CO2 more? Why would we want to threaten more the quality of life in this world?

The Congressman and I have been to Antarctica twice; one of those trips we went together. Down in Antarctica, 90 percent of all the fresh water in the world is locked up in the ice there. It is nearly 2 miles high, and 70 percent of all the world's ice is locked up in Antarctica. Now that hasn't really started to melt yet, although it has threatened. I am told that calculations indicate that if the polarized caps in the Greenland ice shelf, if they were all to melt, the ocean levels would rise 200 feet.

Now, if you look around the world you will note that a big percent of the world's population lives within 200 feet of sea level. This would be a monstrous, monstrous change.

There are three very good reasons for pursuing alternatives, which is what the bill tomorrow is going to be talking about. One of those is certainly a climate change, because what we are doing now is releasing CO2 that was bound up in these plants and organisms that grew aeons ago, and it took many, many years to tie up the CO2. Now we are releasing it very quickly as we burn these fossil fuels.

A second reason, of course, is I just don't think that the oil is going to be there, which is what we are talking about tonight as ``peak oil.''

The third really good reason for doing it is the reason the President advanced, and that is, it really is a big national security risk to be so dependent on foreign oil.

What I have here on this chart is another depiction of Hubbert's peak, and this is by the Cambridge Energy Research Associates, commonly referred to as CERA, and they are trying to indicate that one should not have confidence in the predictions of Hubbert because his curve didn't exactly actually follow his prediction.

Well, by golly, it is pretty close to actually following his prediction. Here is the U.S. actual production in red. You will see there is a little second peak here, and the next chart will show that is because of Prudhoe Bay. We found a lot of oil there, but that was not in M. King Hubbert's prediction. He hadn't imagined that we would be going to the North Slope of Alaska to drill.

So the little yellow ones here are his prediction. Notice that the actual Lower 48 has followed very closely, very closely, his prediction. We are now down to, even with Prudhoe Bay, we are now down to about half, about 5 million barrels a day. That is the red one over there, as compared to roughly 10 million barrels a day at our peak.

The next chart shows better where their oil comes from. Hubbert's prediction covered the Lower 48, and that is this gray area here. Now we need to add to that gas liquids. The big find in Alaska here, and that is what causes this little blip here in the downward slope. I remember a number of years ago, these fabulous discoveries of oil in the Gulf of Mexico, which is supposed

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to solve our problem for the foreseeable future, that is the yellow there. Notice it hardly makes a shadow on the downward slope of Hubbert's peak.

The next chart is really a chart that we could spend a long while talking about because it has a great deal of information on it. The bars there represent the discoveries, and you notice that we were discovering oil way back in the 1930s, big discoveries in the 1940s, and then lots of discoveries which peaked about 1970, and since then it has been going down, down, down.

The solid black line here indicates the amount of oil that we have been using. Notice that for a long while we were accumulating big reserves of oil; everything about this solid black curve is reserves that we have in store that we can use later.

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But then in about 1980 there, you can see these two curves cross. I say two curves, because obviously you could draw a smooth curve through the peaks here, and these two curves crossed about 1980. Ever since 1980 we have been burning more oil than we found. Today we burn two or three barrels of oil for every barrel of oil that we find. So for this period, between 1980 to the present, we have been using up some of the reserves that we have back here, but still a lot of those reserves remain.

Now, what will the future look like? Well, there is a big difference of opinion in what the future will look like. The persons that put this chart together believe that by about 2010, about 3 years or so, the world will peak in oil consumption. Some believe that it has already peaked, others believe it may peak a little after 2010, and then it will go down.

Now, they have made some guesses as to how much oil we are going to find. I am not sure I would have drawn that curve exactly that high, because a smooth curve might bring you down about here. I think they have been very generous in the amount of oil that is yet to be discovered.

By the way, the world's experts on oil believe that we have, most of them, we have probably found about 95 percent of all the oil that we will ever find. You notice that when we find oil now, we find it in very difficult places to get to. The last big find was in the Gulf of Mexico, through 7,000 feet of water, and then about 30,000 feet of rock and dirt until you get down to the oil. We aren't now developing that field, and I am told, you can be told a lot of things that aren't true and I don't know the veracity of this, but I am told we will be developing that field when oil reaches $211 a barrel, because that is what it will cost to get the oil out of that field.

I just want to spend a moment looking at this before we go to the next one. If you draw a smooth curve through these bars, the area under that curve represents the total amount of oil that we have found, and the area under the consumption curve will represent the total amount of oil that we have consumed.

Now, it is very obvious that you can't consume oil that you haven't found, and you can make the future, within reason, look anyway you like. But what you can't do is pump oil that you haven't found. Unless you believe that we are going to find a whole lot more oil than indicated by their projection, then you have some choices as to what that downslope is going to look like.

You can be very aggressive and use enhanced recovery techniques, you can pump steam down there, you can pump CO_2 down there, you can flood it with sea water as the Saudis do to get their oil out. You get it more quickly. But if you get it more quickly, you have less to get later on.

So we have choices facing us as to what that downslope will look like. But, remember, you can't pump oil you haven't found, and the area under the consumption curve cannot be larger than the area under the discovery curve. They have to be the same area ultimately, the same volume.

Here is a prediction by our Energy Information Agency, and it is a very interesting one, and they use some unusual statistical approaches. But this is a curve through the discovery peaks. Let me put the other one up just quickly so you can see the similarities here.

Notice the big peak here in the late 1940s and 1950s and another peak here. They have kind of smoothed that out here. You can see this is the early peak here and then the later peak and then down, down, down.

We get to the point we are at now, and they make some very unusual predictions. The yellow line there, they say, is the 95 percent probability, and the green line is the 50 percent probability, and the blue line is the 5 percent probability. And they say that the 50 percent probability is the average, the mean, and, of course, probabilities and means don't mean the same thing, so therefore, that is what our production is more likely to be.

Surprisingly, this curve that has been going down for a number of years they thought was going to turn around and go up. But notice for the roughly 5 to 10 years after they drew this first curve, notice the red symbols there. They have been following what you would expect they would follow, and that is the 95 percent probability. Ninety-five percent probably is a whole lot more probable than 50 percent probable, and that is what it has been following.

Here is another chart from CERA, and it shows something very interesting. First, I want to look at the left here. This is the low, they say, is the 95 percent probability. Now, the 95 percent probability is the most probable, so it is not the low, it is the most likely.

Then they say the high probability is almost 4,000 gigabarrels. The mean is right in the middle. Most of the experts in the world believe that we have found about a little over 2,000 gigabarrels of oil. I use the term ``giga,'' because a billion in England is a million million, and in our country a billion is a thousand million. So everybody understands giga. A giga is a thousand million. We have consumed about half of that and about 1,000 gigabarrels, maybe a little bit more, but roughly a thousand gigabarrels remains.

Several Congresses ago I was privileged to share the Energy Subcommittee on Science, and I wanted to get some idea of the dimensions of the problem we face, so we had the world's experts come in for a hearing. And I was surprised at the unanimity. It was like from 970 to 1,040 gigabarrels of oil remaining in the world, not a big spread.

Now, what they are showing here is that if in fact we find as much more oil as all the oil that now remains discovered, if we find as much more as all the oil that remains discovered, we will still peak at 2016, 9 years from now, if we find as much more oil as all the oil that now exists, that we know exists in the world. If you don't find that, then we peaked about now and it is going to start down this way.

Another thing they have shown here is if you

aggressively develop these fields and pump life steam down there or put CO2 down there or pump sea water down there, you can get it more quickly. But then look what happens. It falls off more quickly too.

Again, the area under this curve has to be the same thing as the area under this curve. You can't pump more because you are pumping it faster. Now, with enhanced oil discovery, you might get a little more, because you might get some oil that you wouldn't have gotten with conventional techniques.

Here is another more recent chart from the Oil Information Agency. They have been pooh-poohing the idea of peak oil. They said it was going to be an undulating plateau. I agree, it is going to be an undulating plateau. So they show here with what I think are wildly optimistic estimates of how much oil we are going to find, they believe that we are going to find twice as much more oil as all the oil we now know exists. That just isn't very probable.

But even if we find that much oil, they have a peak. Notice it. They say it is an undulating plateau. I agree. With the world's economies and demands and warmer temperatures, which is why oil is down a bit now, because we have warmer temperatures in our country, I agree it is going to be undulating plateau. They are pooh-poohing the idea of peak oil, and they show in this curve peak oil. They show it I think a good many years beyond when it will actually occur.

This little curve down here is closer what I think is reality. They have 1.92 trillion, and it is just a bit over 2 trillion, I think, so maybe it would extend

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a little beyond this. But notice they are showing this peak about now, aren't they? So if we don't find this enormous amount of additional oil, it will be peaking about now. What they are saying is if we have only 2.93 trillion, we will be peaking at this point.

I have a quote here from one of the world's experts on oil, Dr. Laherrere, and this is what he says, and I think that it is kind of difficult to argue with his logic. Jean Laherrere made an assessment of the USGS report.

Now, it is the USGS report that provides the data that permits CERA to make their prognostications. He concludes that the USGS estimate implies a five-fold increase in discovery rate and reserve addition for which no evidence is presented. Such an improvement in performance is in fact utterly implausible, he says, given the great technological achievements of the industry over the past 20 years, the worldwide search and the deliberate effort to find the largest remaining prospects. Today we have 3-D modeling and seismic use, and so we know pretty much what the world's geology looks like.

I might take just a moment to talk a little bit about this geology, because it is very important in understanding how much more oil we are likely to find.

How did the gas and oil get there? Well, nobody was there when it got there, so we really don't know, but one of the best guess its is that a very long time ago the Earth was very much warmer than it is now. As a matter of fact, there were subtropical seas at the North Shore of Alaska. In the North Sea, there were subtropical seas. And every cycle the vegetation grew, and then when it matured or if there was a fall, and it may have been warm enough there was no true fall, but still there was a cycle of life, and it grew and sank to the bottom as algae does now in the ponds and so forth. And then waters washed erosive materials off the surrounding hills and it mixed with the organic material. This continued for an a large number of years until there was a lot of mixture of organic material and inorganic material there.

Then the tectonic plates of the world moved, and we know that happened, and it opened up and sank and went down to a depth where the temperature was appropriate, closer to the molten core of the Earth, and where the pressure was appropriate, and then cooked there under this pressure for who knows how long, and this organic material, mostly plants, maybe a few small animals, gradually became what we know as oil.

Now, the oil is made up of molecules of varying lengths. Some are very short and they are in fact gasses, if you let them escape from the oil. Some of them are very long, and that makes the waxes and so forth that we find in oil.

Now, if there happened to be a rock dome over top of this deposit way down there that is now being cooked and pressurized for a long while, if there is a rock dome over that, the gas that escapes will be trapped under that rock dome. So when you come along and drill a well through that, and you get down to the oil, the oil is going to be under pressure because of that gas above it. So you have what you call a gusher. The gas pressure above pushes the oil down and up the drill pipe and it continues to gush until that gas pressure has been relieved.

Now, this may not be the way that oil and gas were formed, but there isn't any better guess as to how it was formed. And if that is in fact the way it was formed, then we can make some guesses as to how much more oil and gas we are likely to find, because we have done a pretty good job of matching the geology of the Earth.

What you need to find is some of this organic material buried deeply for a long while with a rock dome over it so it captures the gas. By the way, if it doesn't capture that gas, you end up with something like the tar pits of California, and you end up with the tar sands, they call them oil sands, they are tar sands, thank you. They flow about as readily as the blacktop driveway out here, unless you heat them up, which is what they do, and combine them with some shorter chain molecules so that when they cool they will still flow.

The loss of these gasses has produced what we call our oil shales in the west. By the way, there are huge, huge deposits of these tar sands and oil shales.

As a matter of fact, the deposits of each of those represents way more than all the fossil fuels that we now know exist in the world, and the Canadians are making some heroic efforts because their big fields are up in Alberta, Canada, and they have a shovel up there that lifts 100 tons and they dump it into a truck that carries 400 tons and then they carry it and cook it. When it is cooked, why, the oil flows and then they mix it, as I said, with something with shorter molecules, a solvent, so when it cools it will flow and they move it out through pipes. With this heroic effort, they are getting about 1 million barrels a day. That sounds like a lot, 1 million barrels a day, but we use 21 million barrels a day. That is about 5 percent of what we use, and just a bit over 1 percent of what the world uses, because the world uses about 84-85 million barrels a day.

And what they are doing is not sustainable, because they are cooking this with natural gas that is what we call stranded. By ``stranded'' we mean there are not very many people there to use it, and natural gas is hard to transport unless you liquefy it and are near a port, so it is cheap. So I understand they may be using more energy from natural gas to produce the oil than they are getting out of the oil. But from a dollar and cents perspective, it makes sense, because the gas is really cheap and they are producing that oily understand for $12 to $25 a barrel, again, you get various estimates of this, and they are getting $50 to $60 barrel for it. So dollars and cents-wise, that makes good sense.

[Time: 21:30]

From an energy profit ratio, it does not make any sense at all. Natural gas is a high quality feed stock for an enormous petrochemical industry.

One of the things that we use it for, by the way, is making nitrogen fertilizer, and without our ability to make nitrogen fertilizer, we could not begin to feed the world. It is not just the plant breeder, and he has done marvelous with developing new plants. It is all of the fossil fuel energy we use in agriculture, and a great deal of that is used in making nitrogen fertilizer from natural gas.

I have next a little schematic here, and this kind of smoothes out these curves. By the way, the world has been increasing its use of oil about 2 percent. That does not sound like much, does it, 2 percent? But 2 percent exponential growth doubles in about 35 years. It is four times bigger in 70 years, and it is eight times bigger in 140 years.

Albert Einstein was asked after the discovery of nuclear energy and the detonation of the nuclear bomb, Dr. Einstein, what will be the next great energy force in the world? And he said the most powerful force in the universe is the power of compound interest. Exponential growth.

I have a namesake, no relative. I wish I had some of his genes. He is really very brilliant. Dr. Albert Bartlett, professor emeritus at the University of Colorado, he gives the most interesting 1-hour lecture I have ever heard on the failure of our industrialized society to understand exponential growth. Just do a Google search for Albert Bartlett and energy, and it will come up and you will be fascinated with this 1-hour lecture.

Here we show this little schematic curve. It is a 1 percent growth rate. Remember, that doubles in 35-years. This point is twice as high as this point, and that represents 35 years. Notice that the shortage occurs before we reach the peak.

The shape of the bell curve and the exponential growth curve indicate that you are going to have shortfalls in supply, price is going to go up before you might reach the peak, and maybe, just maybe, we are in this time right here. A lot of the evidence indicates that is true.

The next chart is one that really gives you some pause when you look at it. Let us just look at the upper one because the bottom one is an expansion of the upper one, separating the gas from the oil here in the red curve. But this shows only what 400 years, a little less than 400 years of more than 5,000 years of recorded history. The use of energy in our world was so small back in 1750 that that brown there which is

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wood is just about the baseline, is it not?

The industrial revolution started with wood. The hills of England were denuded to make charcoal to make steel. Catoctin Furnace, a little historic site up in Frederick County, they denuded the Catoctin Mountains where Camp David now is, thankfully the trees grew back, they denuded that making charcoal for that furnace.

The industrial revolution really took off when they discovered coal, and it was stuttering when they finally discovered gas and oil. Then look what happened.

The hockey stick, that is the hockey stick that Congressman *Gilchrest* was talking about, look what it did. It just goes straight up. Notice here what happened in 1970. There was a real oil price shock there, and the world used somewhat less oil. We are now very efficient in the way we use oil in this country. Air conditioners probably are twice as efficient at least as the ones you used in 1970. If it were not for our increased efficiency we would be in even more trouble with energy today.

But what I want to point out is that we are about 100, 150 years into the age of oil. That is this. If Hubbert was right, and he was exactly right about the United States, why should he not be right about the world, this is going to be a bell curve. By the way, you can make this thing look steeper or shallower depending upon the dimensions and the ordinates, the absinthe ordinate and abscissa. Here, of course, we have 400 years on the abscissa so it is very compressed so it makes the curve look higher, but that is exactly the same kind of curve we have here. We just spread out the abscissa here so that we spread it out. If you really push these two things, that is going to peak up high in the middle.

Out of 5,000 years of recorded history, the age of oil will represent about 200 to 300 years, remaining about 100, 150 years. What will our world look like post age of oil?

The next chart shows us something that is alarming a number of people, and this is a little drawing of the world. It has a number of symbols on it, and one of those symbols shows where China is securing rights to buy oil, and they are all over the world. This symbol here was Unocal. They almost bought Unocal, one of our oil companies. They are buying oil all over the world. They are scouring the world for oil.

I just came back from a trip to China, and we went there to talk about energy by the way. I was pleasantly surprised when they began their discussion of energy by saying post-oil. They get it. I wish we did. They talk about post-oil. They recognize that they are big polluters. As a matter of fact, I have a reference here that says by 2010, just 3 years from now, they will be a bigger CO_2 producer than we are, in just 3 years. Their economy is growing, the last 2 quarters, at more than 10 percent a year. That doubles in 7 years. It is four times bigger in 14 years. It is eight times bigger in 21 years, 1.3 billion people. I saw essentially no bicycles on the street and traffic jams like we have at rush hour here in Washington.

Well, the fact that they are scouring the world for oil indicates their understanding that this is going to be a resource in short supply for the future. We can spend a long time talking about China and what they are doing. They are aggressively building a blue water navy.

A blue water navy is different than the brown water navy, brown from the silt that comes out the rivers near shore, little navies that protect you from somebody coming from afar. They are rapidly developing a blue water navy. Last year, for instance, we launched one submarine. They launched 14. Now, their submarines are not ours but 14 submarines is 14 submarines.

I have here a very interesting statement from our Secretary of State Condoleeza Rice: ``We do have to do something about the energy problem.'' I am thankful you recognize that. ``I can tell you that nothing has really taken me aback more as Secretary of State than the way the politics of energy is I will use the word `warping' diplomacy around the world. We have simply got to do something now about the warping now of diplomatic efforts by the all-out rush for energy supply.''

It would be nice if everybody in the administration understood that and we were doing something meaningful about it.

So what do we do? Well, I think that any rational person would understand that you need to get busy developing some alternatives if you are going to run out of these fossil fuels. By the way, these fossil fuel are just incredible. The energy in these fossil fuels is just unreal.

I have an article, really not an article. It was a

speech given by Hyman Rickover in 1957, 50 years ago this year, and I want to read something that he says here which is really interesting. He understood 50 years ago, ``With high energy consumption goes a high standard of living. Thus the enormous fossil fuel energy which we in this country control feeds machines which make each of us master of an army of mechanical slaves. Man's muscle power is rated at 35 watts continuously,'' little more than you are working, but you have got to sleep, ``or one-twentieth horsepower. Machines therefore furnish every American industrial worker with energy equivalent to that of 244 men, while at least 2,000 men push his automobile along the road, and his family is supplied with 33 faithful household helpers. Each locomotive engineer controls energy equivalent to that of 100,000 men; each jet pilot of 700,000 men. Truly, the humblest American enjoys the services of more slaves than were once owned by the richest nobles, and lives better than most ancient kings. In retrospect, and despite wars, revolutions, and disasters, the hundred years just gone by may well seem like a Golden Age.''

And it has gotten even more golden in these last 50 years, has it not?

Hyman Rickover understood very well our dependence on fossil fuels. One barrel of oil controls the energy of 12 men working all year for you. If you figure out what that costs, it is less than $10 to purchase the equivalent work of a person all year long.

Now, if you have some trouble getting your minds around that, imagine how far that gallon of gasoline or diesel fuel carries your car. And by the way, it is considerably cheaper, a little over $2 a gallon, than water in the grocery store.

Now, how long would it take you to pull your SUV or your car or push it as far as that little gallon of gasoline or diesel fuel take it? I own a Prius. We get under normal road driving conditions 51 miles a gallon. It would take me a long time to pull my Prius 51 miles.

Another indication of the incredible energy benefit from fossil fuels, if you work really hard all day long, I will get more work out of an electric motor for less than 25 cents worth of electricity.

It may be humbling to recognize in terms of fossil fuel that we are worth less than 25 cents a day, but that is the reality, and that is why we live so well.

As Hyman Rickover understood 50 years ago, if that was true what he said 50 years ago, it is true in spades today, is it not, because we have even more helpers to make our life quality higher as a result of our use of energy.

Well, what do we do if we are going to run short of fossil fuels? Obviously, we have no surplus oil to invest in the development of renewables. If we did, oil would not be $50, $60 a barrel, but we can free up some oil and buy some time with a very aggressive conservation program.

Matt Simmons, who has written a really good book on Saudi Arabia called ``Twilight in the Desert,'' and he makes the case that Saudi Arabia has probably peaked in oil production. They will not tell you that, but you notice they cannot make good on any promise to increase oil production so he may very well be right. Then after having freed up this energy and bought some time, we must use it very wisely. We would get a lot of benefits from that.

Life is just so easy in this country that we are bored. We are watching awful movies. We are doing drugs because we are bored. There is no exhilaration like facing a big challenge and besting that challenge. There is nothing that puts flavor in pie so much as work, and I can imagine Americans, when they understand the problem we face, going to bed at night saying, gee, today, I used less energy than I did yesterday and I lived just fine, and tomorrow I am going to do better.

But we need leadership that is not here yet so that we will do that. By the way, big benefits. We could once again become a major exporter. We are the most creative, innovative society in the world. Properly challenged, we will figure ways to get this alternative energy. We could again be a major exporter. Today, we are a big, big importer, as you know, $800 billion trade deficit this year.

We are a role model whether we like it or not. When you use 25 percent of the world's energy, you are a role model. Not a very good one today. We profligately use energy, way more energy than the average person in the world. It really is possible to be much more efficient.

This is a fascinating chart, such a simple one, but what it shows is the heat that you get out of an incandescent bulb and the light you get out of it. Ninety percent of it is heat which is why I use an electric bulb for brooding little chickens. I am not so much interested in the light as I am the heat from it. Now fluorescents are much better, and I saw there was a Time magazine cover page that had a pile of coal there. I think it was on the cover page, and they have one of these screw-in fluorescent bulbs beside it. Five hundred pounds of coal, that is the amount of coal you save in the life of that one fluorescent bulb, that is here.

But notice what you get out of light omitting diodes. I have a little light omitting diode flashlight that I carry. I put two little batteries in it, and I have forgotten when I put them in.

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It just lasts so long. We have the same amount of light out of each one of these, but notice the enormous amount of heat you are getting out of the incandescent bulb and the tiny amount of heat that you are getting out of the light emitting diode.

There are lots of opportunities in our society to live well and comfortably using a lot less energy. I don't have the chart here, but the average Californian uses only about 65 percent as much electricity as the rest of America, and it would be hard to argue that Californians don't live well.

This next chart is a really interesting one, and what it shows here on the abscissa is the amount of energy that we are using per person and what it shows on the ordinate here is how good you feel about life. You couldn't feel any better than 100 percent, and notice where we are. We are the biggest users of energy in the whole world and we feel pretty good about it; but notice how many countries that use less energy than we feel even better than their quality of life. Let's go way back here to Colombia. They use a fifth as much energy as we; they feel almost as good about their quality of life as we feel.

If you drew a curve through this, you need some minimum energy to feel good about life, but once you go up that steep part of the curve, the minimum energy is pretty flat. We can move way back here on the curve and feel just as good as we do now about life. You don't have to use the amount of energy that we use to feel as good about life as we do.

The average European, the countries are scattered through there, but the average European uses half the energy we use and, by the way, pays more than twice as much per gallon of gasoline and they have been doing that for a very long time.

We are shortly going to run out of our 60 minutes this evening and we will need to come back to finish this, but obviously we have got some finite resources here that we can use. When we come back, we are going to talk about the resources available to us to meet the challenge of transitioning from fossil fuels to renewables. And, by the way, we will transition either on a time scale that we have chosen or on a time scale chosen by geology.

As we run down the other side of Hubbard's Peak and the world has less and less supply of fossil fuels, we will transition. It can be a bumpy ride, or it can be a really bumpy ride. But Americans are up to it. We need leadership and knowledge. And we will be back again to talk about the finite resources available to us and all those fascinating opportunities in renewables.

END

Congressman Roscoe Bartlett
Congressional Record
PEAK OIL, Part II

THE PROBLEMS WITH FOSSIL FUELS: ALTERNATIVE ENERGY SOURCES
House of Representatives
January 18, 2007

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@20:30 (8:30 PM) Eastern

The SPEAKER pro tempore (Mr. *Murphy* of Connecticut). Under the Speaker's announced policy of today, the gentleman from Maryland (Mr. *Bartlett*) is recognized for 60 minutes.

Mr. BARTLETT of Maryland. Mr. Speaker, last evening we were here just about this time talking about this same subject, the subject we have been talking about for the last hour. We had been discussing the phenomenon known as peak oil. That is the term given to a prediction that a geologist made, M. King Hubbert, working for the Shell Oil Company in 1956. He gave a speech in San Antonio, Texas, which I believe within a decade will be recognized as the most significant, most important speech given in the last century.

What he predicted was that the United States, which at that time was king of oil, we were producing more oil than any other country. We were using more oil than any other country, and we were exporting more oil than any other country. M. King Hubbert had the audacity in San Antonio, Texas, in 1956 to predict that in just a bit less than a decade-and-a-half, by about 1970, he said that the United States would reach its maximum oil production, and after that, inevitably, no matter what we did, oil production would tail off.

That prediction came true. Surprisingly, in 1970, some may say 1971, we peaked in oil production. In 1969, using this same analysis technique, he predicted that the world would be peaking in oil production about now. So last night we had come in our discussion to the point that we were looking at the potential for the alternatives that we and the world would need to turn to as we slide down the other side of what is referred to as Hubbert's peak. We noted that there were some finite resources, some nuclear resources and then the true renewables.

There are three justifications one might use for moving to alternatives. One is peak oil, and we will transition from fossil fuels to alternatives. Oil, gas and coal obviously will not last forever, and as the earth at some point runs down the other side of what we call Hubbert's peak and there is not enough oil, gas and coal to meet our

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energy needs in the world, we will transition to alternatives. The only question is whether we do that on a time scale that we control so that it is a pretty easy ride, or whether we do it as dictated by geology, where it may be a very difficult ride.

Two other reasons for moving to alternatives. One is our dependence on foreign oil. Today, we have only about 2 percent of the known reserves of the oil in our country. We use about one-fourth of all the oil in the world, and we import about two-thirds of what we use. Obviously, if M. King Hubbert was right about the world, and there is every reason to believe he will be right about the world, we will need to transition to alternatives.

From a national security perspective, we ought to have been doing this a long while ago. A couple of years ago, 30 prominent Americans, Jim Woolsey, Boyden Gray, McFarland and 27 others, wrote a letter to the President saying, Mr. President, and they used the statistics I just used, the fact that the United States has only 2 percent of the known reserves and uses 25 percent of the world's oil and imports almost two-thirds of what we use is a totally unacceptable national security risk. Mr. President, we really need to do something about that. So even if you think that there is a whole lot of oil and gas out there, you still may be very incentivized to look for alternatives if you are concerned about our national security.

There is another reason to look for alternatives, and that is, if you believe that we have global warming, and I think there is an increasing body of evidence that suggests that that is probably true, and that we are probably contributing to that, although in the past the earth has been very much warmer, this is in a very distant past. Ordinarily, the past that we are talking about is from the last ice age, which is like some 10,000 years back. It is now the warmest we have ever been since that last ice age, but sometime way in the past the earth has been very much warmer because there were apparently subtropical seas in what is now the north slope of Alaska and the North Sea because we are finding oil and gas there.

The general belief is that this oil and gas was produced by organic material that grew in these subtropical seas, that every season it matured and fell to the bottom and was covered and mixed with sediment that was washed off of the adjacent hills, and then that built up for a very long time. Finally, with moving, the tectonic plates was submersed down with enough pressure and enough heat from the molten core of the earth and enough time that this finally was processed into gas and oil, and then if there was a rock dome over it which would hold the gas, now you have a very fertile place in which to drill. It took a very long time to grow all of that organic material and to turn it into gas and oil.

We are now in a relatively few years releasing all of the carbon dioxide that was sequestered in this organic material over quite a long time, until we are driving up the CO2 of the world, which in the last century or so is nearly twice now what it was a century or so ago. This is what we call a greenhouse gas.

You can get some idea as to the greenhouse effect. If tomorrow is a sunny day and a cold day, and if your car is parked outside with the sun shining on the windshield, you may find quite a warm car when you go out there. That is because of what we call the greenhouse effect. The light that comes in from the sun, call it white light, it comes in over a long spectrum of wave lengths, and it goes through the glass of your car. Then it warms up the material of your car and it reradiates only in the infrared. Well, the glass of your car is pretty much opaque to the infrared. It keeps the heat inside. It reflects it back, and that is why your car gets so warm.

The greenhouse gases out there, you may remember being in an airplane, you are 44,000 feet, and the pilot tells you it is 70 degrees below zero, when down just below you may be flying over south Florida where it is very warm, and this is because of the greenhouse effect. The energy coming in from the sun heats up things in the earth, and when that heat is reflected back out, emanated back out, it is reflected by what we call the greenhouse gases and CO2 as one of those.

So there is increasing evidence that we have global warming, and there may be a need to move to the alternatives because many of these alternatives, although they will produce CO2 when you burn them like ethanol, that CO2 was taken out of the atmosphere by the corn plant when it grew. So you are not contributing any more CO2 to the atmosphere if you are using a product that just last year or so took the CO2 out of the atmosphere.

Now, what you would want to do in these last 2 cases is a little different in moving to alternatives. We have a essentially run out of time and run out of energy to invest in alternatives. We absolutely knew by 1980 that M. King Hubbert was right about the United States. We had peaked in 1970. We have done nothing in the ensuing years. If M. King Hubbert is right about the world, we have no excess energy to invest or oil would not be $50, $60 barrel, which means we have essentially run out of time and have no energy to invest.

[Time: 21:45]

Now, we could buy some time and free up some energy with a very aggressive conservation program.

Now, if your concern is foreign oil, then you could also get some additional energy from such things as tar sands and oil shales and coal. But if your concern is global warming, this will be a very bad place to get energy to invest in the alternatives that we will ultimately have to transition to because it take a lot of energy to get energy out of tar sands, and that energy is fossil fuel energy and that releases CO2 into the atmosphere.

So you are making a bad situation worse if your concern is global warming and you think CO2 is the cause of that and you want to transition to renewables, and you are going to get the energy to transition to renewables from tar sands and oil shales and particularly in coal somewhat. You will simply be releasing more carbon dioxide into the atmosphere. But let's look at these, because if the other two incentives are your incentives, then these are good bets.

If you are simply concerned that we have got to transition to renewables, then you will use whatever energy is available, and there is potentially enormous amounts of energy available in these tar sands and oil shales. And if you are concerned about dependence on foreign oil, then this is a good place to begin.

The tar sands. Some may call them oil sands; they are tar, thank you. It doesn't flow; it is really very much like tar. It is, I guess, a bit better than the asphalt parking lot out here, but not much better. If you put a blow torch on the parking lot, that will flow, too, which is pretty much what we have to do with the tar sands. They exist in Canada around Alberta, Canada. There is an incredible amount of potential energy there. There is more energy in these tar sands than in all the known reserves of oil in the world.

But why aren't we resting easy, then, that we have got an easy transition, a big source of energy? Because this energy is not all that easy to get out of the tar sands. The Canadians are now getting about a million barrels of oil a day. That sounds like a lot of oil, and it is a lot. It is a little less than 5 percent of what we use in our country and just a bit more than 1 percent of the 84 million, 85 million barrels a day that the world uses; but they are using an incredible amount of energy to get this.

They are mining this, if you will. They have a shovel there that lifts 100 tons at a time, they dump it into a truck that hauls 400 tons, and then they take it and they cook it, and they are cooking it at the present with natural gas. They have what is called stranded natural gas there. There are not very many people in Alberta, Canada, that use it and gas is very difficult to move long distances; and so they are using this gas to produce oil from the tar sands.

I am told, and you can be told a lot of things that aren't true, but I am told that they may be using more energy from the natural gas than they are getting out of the oil that they produce. But from an economy perspective, that is okay, because the gas is very cheap and the oil is very expensive. And I understand it costs them $18 to $25 a barrel to produce the oil; and if it is selling for $50, $60 a barrel, obviously there

is a big profit there. But this natural gas will not last forever.

And where will the next energy come from? They are talking about building a nuclear power plant there so they will have additional energy for cooking this oil.

And they have another problem. The vein I understand, if you think of this as a vein, it now ducks under a big overlay of rock and soil, so that they will not be able to continue to develop this by mining it which is what they are doing now. They will have to develop it in situ, and I don't know that they have any economically feasible way of developing it in situ.

So although there is an incredibly large amount of potential energy available there, it will take a lot of energy to get it out, so what you really need to be thinking about is the net energy or the energy-profit ratio that you get out of this.

Who knows what new technologies we may come up with, what the engineers may be able to do, but one should not be too sanguine that this will be a savior, that we will get enormous amounts of energy from this, because of the difficulty of getting the oil out.

The oil shales. The name might better be called tar shales, but we refer to oil shales, and they are found in our western United States, in Utah and Colorado and so forth. And, again, there is absolutely an incredible potential amount of oil that could be extracted from these oil shales, or tar shales. Probably more than all of the known reserves of oil in the world, if we could get it all out. There have been a couple of attempts to do that. The most recent one was by the Shell Oil Company, and there was some glowing reports in the papers about what they did there. But there are aquifers associated with this shale that they need to protect, and so what they do to develop this is to go in and drill a bunch of holes around the perimeter and then freeze it.

So they in effect have a frozen vessel, and the oil will not move through that frozen vessel. And then they drill wells in the middle of it and they cook it, and they cook it for a year. And then they drill a third set of wells, and then when they get to the bottom, they go horizontally. They are very good at doing that now. So the oil that they cooked, loosened up by the second set of wells they drilled, now flows down through the shale, into the well that they drilled that finally went horizontal, and then they pump it out of those wells, and then they pump it for several years and they get a really meaningful amount of oil out.

A couple of years ago I was out in Denver, Colorado, speaking to a peak oil conference there, and the engineer, the scientist who did this little experiment cautioned that it would be several years before Shell Oil Company decided whether it was even economically feasible to get any oil out of the oil shales using that technique. Now, there may be other techniques, but at present to my knowledge nobody has any big exploitation

of the oil shales. The one that got the most publicity was this experiment by the Shell Oil Company, and they have indicated it would be several years before they can determine whether $60 a barrel is even feasible to get that oil.

The next one here is coal, and we will put another chart up in front of this one, because we hear a lot about coal. And you may hear it said that we have 250 years, 500 years of coal. We don't have 500 years, but we do have 250 years of coal at current use rates. Be very careful when people are telling you how much we have of some resource. If it is at current use rates, you have to factor in how long it will last you if you have an increased use rate.

After the development of atomic energy, and the world was amazed by that, Dr. Albert Einstein was asked: What will be the next great energy source in the world? And he said the most powerful force in the world was the power of compound interest.

And when you look at exponential growth, if you increase the use of coal just 2 percent, and I submit that we will have to dig into coal much more than just 2 percent increase per year over what we now use, but if it is only 2 percent, that 250 years immediately shrinks to about 85 years; and then you can't fill your trunk with coal and go down the roads. You have to convert it to a gas or liquid. And, by the way, we have been doing this for decades. Hitler ran his whole military and his whole country on oil from coal. When I was a little kid, the lamps that you now call a kerosene lamp we called coal oil lamp because it was coal oil that replaced whale oil in the lamps, and long after we were using kerosene I still called it coal oil.

But if you use some of the energy from the coal to convert the rest of the coal into a gas or a liquid, now you are down to 50 years with just 2 percent growth rate. And there is something else to look at. Because oil is fungible and moves on a world market, and it really doesn't matter in today's world who owns the oil, the guy who bids the highest gets the oil. It all moves on a global marketplace. And since we use one-fourth of the world's oil, our 50-year supply at only 2 percent growth rate will last the world just one-fourth of 50, or 12 1/2 years.

So the coal is there. It is the most readily developed, unconventional fossil fuel energy source, and we need to husband it. But it is dirty. You will pay an environmental penalty if you use it without cleaning it up, or you will pay a big economic penalty if you clean it up.

Let's go back to the original chart we were looking at. And the previous speakers talked about nuclear, and indeed today we produce about 20 percent of our electricity, 8 percent of our total energy from nuclear. We could and maybe should do more. There is no energy source that is without its drawbacks. When you burn any fossil fuel, you release CO_2 into the atmosphere and that produces greenhouse effects, which might very well produce global warming. There are potential drawbacks to nuclear, but so are there drawbacks to not having enough energy for your civilization.

There are three ways in which we can get energy from nuclear materials. One of them is the lightwater reactor, which is the only kind of reactor that we have in our country that uses fissionable uranium, and there is not an inexhaustible amount of fissionable uranium in the world.

And one of the big problems in this whole dialogue is agreement on what the facts are. When I ask how much fissionable uranium remains in the world, and I guess you have to say at current use rates, I get numbers that range from 15 years to 100 years. We desperately need an honest broker to help us agree as to what the facts are so that we can have a meaningful dialogue.

I have thought a lot about this, and perhaps the National Academy of Sciences, which is highly respected and very knowledgeable, would be this honest broker. Because when we sit at the table discussing where we are and where we need to go, you can't have a rational discussion without agreeing on the facts. But nobody disagrees that there is an inexhaustible supply of fissionable uranium. So obviously at some point in a few years, or a few more years with building more nuclear power plants, and China wants to build a lot more nuclear power plants, we will run out of fissionable uranium.

And then we will have to move to the second type of energy released with nuclear fission, and that is the breeder reactor. The only breeder reactors we ever had were those that were used for producing nuclear weapons. France produces about 80 percent, 85 percent of its electricity from nuclears, and they have some breeder reactors. The breeder reactor does what its name implies, it breeds fuel, so you now will have essentially a replaceable and therefore inexhaustible amount of fuel.

But there are problems that go with the breeder reactor. It has waste products that you have to somehow store away for maybe one-quarter of a million years. Now, we have only 5,000 years of recorded history. It is hard for us to imagine one-quarter of a million years. Something that is so hot that I have to store it away somewhere for one-quarter of a million years I think ought to have enough energy in it that we ought to be able to do something productive with that energy. As a matter of fact, the usual nuclear power plant gets only a tiny percentage of all the potential energy out of the nucleus.

So I would like to challenge our engineers to look at a way to make something good out of what is now a big problem when you have breeder reactors, and that is a byproduct that you

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need to store away for very long time periods.

The second type of nuclear energy release is what is called fusion. And we have a great fusion reactor; it is called our Sun, which is a mediocre star over near one end of the Milky Way. By the way, if you go someplace where the air is not so polluted and you look up at night, you can see across the sky that great Milky Way. It looks like you have taken a brush across the sky. There are just billions and billions of stars out there.

[Time: 22:00]

All of the stars are the equivalent of our sun, by the way. Nuclear fusion, power plants, if you will, and we are kind of a mediocre one near one end of the Milky Way.

We invest about $250 million a year in nuclear fusion. I happily support that. I wish there was a technology out there to and a technologist to use more money. I would happily vote for that. But if you think that we are going to solve our energy problems with nuclear fusion, you probably have some confidence you are going to solve your personal economic problems by winning the lottery. The gamble is about the same.

I think there are huge, huge engineering challenges with nuclear fusion. We have been working for many years, and we are always about 20-30 years away from a solution. We have been 20-30 years away from a solution for the last 20-30 years. We may get there. But it is not the kind of thing that you would want to bet the ranch on. By the way, we are home free if we get that. That would be an inexhaustible source of energy, essentially pollution free except for thermal pollution.

I would like to talk about thermal pollution in our power plants. We have had the luxury in this rich country we live in to put our nuclear power plants away from where we live, and the heat energy that comes out of them, we dissipate. If you drive, you see the big cooling towers for the nuclear power plants. What we are doing is we are evaporating drinking water to cool these power plants.

Almost everywhere else in the world, whether it is nuclear or coal, no matter what it is, unless it is hydro, then it is where the water is, but every other power plant is pretty much in the city right where people live, and they use the heat from that for what they call district heating. They pipe it to homes and businesses, and they use it in the wintertime to heat. In the summertime, you can use the heat to cool by the ammonia refrigeration, ammonia cycle refrigeration system, which used to be very popular in this country. But now you have to buy one from Argentina if you want one, for some reason. They have no moving parts and last a very long time. You can get cooling out of heat. So you can both heat and air conditioning with the excess heat from these power plants if you simply sited them nearer where people live.

Once you have used these finite resources, and they are finite, except for the nuclear that we have discussed. The others are finite. They will not last forever, then we will have only the true renewables left. They are such things as solar and wind and geothermal. This is true geothermal.

You may have people talk to you about geothermal and they are talking about connecting your heat pump to the earth or a well. What you are doing with your heat pump in the summertime, your air conditioner is really trying to heat up the outside air, that is how it cools the inside. And in the wintertime, your heat pump is keeping you warm by trying to cool down the outside air.

If you are working against groundwater, and here it is about 56 degrees, groundwater looks very cool in the summertime, and it looks very warm in the wintertime. I remember as a little boy we had a springhouse on our farm, and that is where our food was kept cool. I used to wonder how does that happen.

In the summertime I went into the springhouse and it was so cool. And in the wintertime, it felt so warm. Of course it was essentially the same temperature. But in contrast with the hot summer air it felt cool, and in contrast with the cold winter air it felt warm.

True geothermal is where we are connected to the heat from the molten core of the Earth. If you have been to Iceland, there is not a chimney in all of Iceland because they have geothermal and they get all of their heat sources from that.

Several places in our country we can tap that, and wherever we can we should. It is not really inexhaustible. The molten core of the Earth will not be there forever, but it will be there for millions and millions of years, so from our perspective that is an inexhaustible source of heat so we include it under renewables.

Then we have a number of sources of energy from the oceans. There is huge potential from the oceans. The tides, and by the way, the tides are one of the few energy sources that are not either the direct or indirect result of the sun. All of the fossil fuels that we are burning, gas and oil, and all of these tar, sands and oil shale were all produced by organic material that grew because the sun was shining a very long time ago.

I knew that when I was a little boy for coal because we lived on a farm in western Pennsylvania, and there was a coal mine on our farm. There had been a cave-in and they simply took the mules and the people out an air shaft that had a walkout slope, and so there was still some coal left. There was not enough to open the mine, but we partnered with a miner from the local town but he opened the mine and they drug coal with a pick and a shovel and a wheelbarrow. So we had what was called run-a-mine coal. We had a coal furnace, as did everybody in western Pennsylvania. Some of the lumps were too big to get in the furnace. Leaning against the cellar wall was a sledge hammer. If the lump was too big, you would break it. I remember breaking those lumps of coal and they would break open and there would be the imprint of a fern leaf. I still get a chill when I think about that.

Here I am looking at something that grew who knew how many eons ago. So I knew very well where coal came from, it came from vegetation that had fallen and was overlaid with Earth.

You can see coal in the process of production, by the way, in the bogs of England. It is not yet coal but it is on the way to coal. And if you take it out, it will burn.

The sun produces most of the energy that you can get from the oceans. It produces thermal gradients. It produces the waves. How does it do that, by producing wind. The wind is the result of the differential heating of the Earth, and that therefore is sun driven.

There is one big potential source of energy in the ocean that is not sun generated, and that is the tides. They are generated by the gravitational pull of the Moon, which lifts the whole ocean 2 to 3 feet.

Can you imagine the incredible amount of energy it takes to lift three-fourths of the earth's surface 2 or 3 feet a day. We have tried to get meaningful energy from the tides without a whole lot of success, and it is simply because they are so disperse. There is an old axiom, energy or power to be effective must be concentrated, and the tides are anything but concentrated. They are spread over huge, huge expanses.

We get some meaningful energy from the tides in the fjords where because of funneling effects you may have a 60-foot tide. You let it come in and then you wall it off and let it flow out through a generator when the tide goes out.

There is another potential source of energy from the oceans, it is not really oceans but you find most of it there, and that is gas hydrites. There is more potential energy in the gas hydrites I understand than in all of the fossil fuels in all of the Earth, but we have been singularly unsuccessful in trying to collect those little nodules of gas hydrites and get the energy from them because they are dispersed largely on the ocean bottom over enormous expanses of the ocean. Well, these are all challenges. And one day when energy becomes less and less available from fossil fuels and more and more expensive, some of these other sources will be more exploitable.

And then the agricultural resource, and let me put the next chart up here.

I would like to start on the left-hand side of this because it really shows us where we are and the challenges we face. We are very much like the young couple whose grandparents have died and left them a pretty big inheritance, and so they have established a life-style, pretty lavish life-style where 85

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percent of the money they spend comes from their grandparents' inheritance and only 15 percent, some people will say 14, 15 percent comes from their income. They look at how old they are and how much they are spending, gee, it is going to run out before they die, before they retire, as a matter of fact. So they obviously have to do one of two things, or both: They have to make more money or spend less money. That is pretty much where we are with energy.

Three-fourths of all of the energy that we use comes from fossil fuels: Petroleum, natural gas, and coal.

Only 15 percent of it comes from something other than fossil fuels. Eight percent comes from nuclear power, and that is 8 percent of our total energy. Nuclear power represents 20 percent of our electricity. If you don't like nuclear power, imagine when you go home tonight that every fifth business and every fifth home doesn't have any electricity because that's what the picture would be if we didn't have nuclear power. So 8 percent. And this is data from 2000. It is a little different because we have been trying to do something since then.

Seven percent of the energy represents the true renewables, like solar and wood and waste and wind, conventional hydro. Agriculture, here we have alcohol fuel and then the geothermal that we talked about where you are truly tapping into the heat from the molten core of the Earth.

These numbers would have to be a little bigger now, but they would have to be a lot bigger to be relevant because in 2000, solar was 0.07 percent. That is trifling. It has been growing at 30 percent a year so it is several times larger than it was in 2000. But still, it is minuscule compared to the 21 million barrels of oil that we use per day.

And 38 percent of this comes from wood and that's largely the paper and timber industry burning waste product.

Then a very interesting one, waste to energy. A lot of people look at the incredible amount of waste we have and say if we could just burn that waste, we could get a lot of energy from that. That's true.

As you go up into Montgomery County, they have a very nice one, I would be proud to have it beside my church. You don't even know it is a waste to energy power plant. It is a nice looking building and the train or the truck comes in and the waste is all in containers and you don't even see it.

But let me remind you that almost all of this waste is the result of profligate use of fossil fuel energy. What you are really doing when you burn that waste to produce electricity is you are kind of burning secondhand fossil fuels because that's what was used to produce this waste. In an energy deficient world, there will be far, far less waste because waste is a by-product of large energy use, and in an energy-deficient world we would be using nowhere near as much energy.

Wind. Wind is really growing. Our previous hour talked about wind. The wind machines today are huge. You may see the blades for them go down the highway. They may be 60 feet long, as big as an airplane wing. They are huge, and produce megawatts of electricity. They are producing them at about 2.5 cents a kilowatt hour.

By the way, because we did not have the proper incentives in our country, we have now forfeited the manufacture of this product. Almost all I understand of the new big what I think are handsome wind machines are made overseas. Most are made in Denmark.

The cheapest electricity costs several times the 2.5 cents a kilowatt hour, so wind machines are now really competitive with other ways of producing electricity.

There are a lot of siting problems, a lot of nimby kinds of reactions. That is, not in my backyard. My wife says these are really bananas, build absolutely nothing anywhere near anybody, she says is the attitude of many of these people.

You know, pretty is as pretty does, and if your alternative is shivering in the dark in an energy deficient fossil fuel world, that may be what we are coming to, and wind machines may start to look a whole lot better. I know some people who live along the coast would mind wind machines if they couldn't see them, so they are trying to site them out in the ocean beyond the horizon so they won't see the wind machines.

[Time: 22:15]

Conventional hydroelectric. You see, that is the biggest sector of these renewables. We have about maxed out on that. We have dammed every river we should have dammed and maybe some we shouldn't. The migratory path of fishes, and I saw a big article the other day about eels, we are now building some ladders so that eels, which are snake-like fish, can get back to their spawning grounds, but there is a huge potential, I understand, maybe as big as that, from something called microhydro. And that is using the water flow and drop in small streams. And there you can use it without the big impacts on the environment that you have when you dam up a big river.

By the way, if you have dammed that river up for water for a downstream city, that will become less and less effective as it gradually fills in with silt, and it will. And by and by, who knows how many years later, there will be little water there because it will be mostly filled with silt that came down from further up in the watershed.

If you are just interested in electricity, it still, when it comes over the dam, falls the same distance. So that silting in won't really effect how much electricity you can produce, but it will affect how much you can vary the height of the reservoir so as to always maintain some reserve for producing the electricity.

I would like to spend a few moments talking about energy from agriculture. There is an awful lot of hype about energy from agriculture. I read the other day, and I don't know why it took us so long to find this, but in 1957, 50 years ago this year, Hyman Rickover, the father of the nuclear submarine, gave a talk to a group of physicians. It is an incredible speech. He was so prophetic. He understood that gas and oil were not forever. That, I think, is obvious.

Maybe it is because I am a scientist, but probably 40 years ago I started asking myself the question, you know, since gas and oil obviously are finite, they are not infinite, they will not last forever, at what point do we need to start being concerned about what is left? Is it a year, 10 years, 100 years, 1,000 years? I didn't know when I first started asking this question. But I knew that at some point in time the world would have to start thinking about, gee, what do we do when gas and oil and coal are gone? Because one day gas and oil and coal will be gone.

So there is a lot of hype about energy from agriculture. But Hyman Rickover, very, very astutely observed that as our population increased, the ground would be more used for producing food than it would be something you burned or fermented. And he also noted, talking about biomass, that biomass might be more valuable returning it to the soil so that you still had soil rather than taking it off to either burn or ferment.

We will get some energy from agriculture, but every bit of corn you use to make ethanol is corn that is not used as a food. We are well fed in this country, many of us more than well fed, but tonight, about 20 percent of the world will go to bed hungry. But as our population continues to increase, there will be less and less opportunity to use agriculture products for energy rather than food.

By the way, there is one way we could free up a lot of agricultural products for energy. If you will eat the corn and the soybeans rather than the pig and the cow that ate the corn and the soybeans, then you could free up a lot of corn for ethanol and soybeans for biodiesel. The animal breeder may brag he has a pig or a chicken that is so efficient that three pounds of corn will make one pound of pig. That is true. But that is three pounds of dry corn and one pound of wet pig; maybe 90 percent dry matter in the corn and for sure 70 percent water in the pig. And you can't eat his bones.

And so on a dry matter to dry matter basis, it takes at least 10 pounds of dry matter in corn to make one pound of dry matter in the pig or the chicken, and probably 20 in the steer. You get very much more efficient conversion of these grains and beans into good food if you use milk.

A cow will today produce 20,000 pounds of milk in a year with a ton of dry matter. She doesn't weigh a ton, but you have a ton of dry matter in her

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milk for the year, which has very high food value. There is no protein that is as good as milk protein. We determine the quality of protein by feeding young rats. It may not be complimentary that the animal has dietary requirements nearer us than any other, rats, but they do. And they are also omnivorous. And we determine how good their protein is by how fast young rats grow.

If you assign a value of 100 to milk protein, eggs come in at about 96, and the meats on down. And that shouldn't surprise you. God or nature, or whoever you think did it, obviously designed milk to grow young animals. A 100-pound sheep will put a pound each on twin lambs just from her milk. Enormously efficient. And eggs are very efficiently produced compared to producing the chicken that you eat.

So we can free up a lot of these food crops for energy if we will simply eat the food crops rather than processing them through animals.

The next chart shows one of the challenges in producing ethanol. Indeed, there are some scientists who believe that we use more energy in producing ethanol, more fossil fuel energy in producing ethanol than we get out of it. I hope they are wrong. I believe that it can be possible. But even after you have made the ethanol, you still have all of the protein and all of the fat left in the corn, and that is pretty good feed.

Just an observation about what we eat and give to our animals. If you go to the Orient, the main protein source there for people is what is called tofu, and that is soybean protein. In this country, we take the soybean and we express the oil, which is the least valuable nutritionally, and we use the oil and we feed what is left of it to our pigs and chickens. No wonder that they are healthier than many of us.

Here is a little comparison of the energy inputs in producing ethanol and in producing gasoline. Obviously, you expend some energy. You don't get all the energy from the oil in your gas tank. You expend some of that in drilling it, in pumping it, transporting it, refining it and hauling it to the service station, and so forth. So you use 1.23 million Btu's to get 1 million Btu's.

Well, what is the story with corn? Now, you have a lot of free energy with corn. You have the solar energy, the photosynthesis that makes the corn grow. And this is about as good as it is going to get. To get 1 million Btu's of energy out of corn, you are going to have to spend about three-fourths of a million Btus in growing the corn, harvesting it, processing the ethanol, and so forth.

Down at the bottom here is a very interesting pie chart, and it shows something that very few people know, and that is that almost half the energy that goes into producing corn comes from nitrogen fertilizer, which is now made from natural gas. So this is a fossil fuel input. This is all fossil fuel input, by the way.

You just go around this little pie here and you are talking about mining the potash, and mining the phosphate, and mining the lime that makes the soil sweeter so that the nutrients can be absorbed. The diesel fuel in the tractor, the gasoline, the liquid propane gas, the electricity you use is produced by

fossil fuels. The natural gas you use for drying your crops, for instance, the custom work, the guy you hire to come.

And then all of the chemicals, something that we rarely, rarely reflect on. Gas and oil are huge feedstocks for a very important petrochemical industry. Most of our insecticides, most of our herbicides and so forth are made from gas and oil. And this is the contribution they make to growing corn. It is really, really quite large there, isn't it?

I have been told that 13 percent of our corn crop would displace 2 percent of our gasoline. But the only fair way to look at the contribution ethanol can make is to grow corn with energy from corn, and you can do that. But if you grow corn with energy from corn, to get a bushel of corn to use here, you have to use three bushels of corn. Remember, the 750,000 Btu inputs to get a million? You need three bushels going in to get one out, which means that it is one to four. You only get a fourth of it out, which means that you are going to have to use 52 percent of your corn crop to displace just 2 percent of our gasoline.

So when you are hearing the euphemistic projections of how much of our gasoline we are going to displace with ethanol, just remember these numbers.

Now, some people are even more enthusiastic about what is called cellulosic ethanol. Cellulose and lignin, particularly cellulose, we can't digest. It is made up of a whole long string of glucose molecules, which is a simple sugar; half of what we call sucrose, which is a double sugar disaccharide. But they are so tightly bound together, we don't have any enzymes in our gut which will release them. And neither does any other animal, by the way.

So, gee, you might say, how do cows, sheep, goats, horses, and guinea pigs make do eating grass and hay? They make do because they have in their gut what are called comincils, animals or little critters that live in there, some of them multi-cellular, some single cells, that have chemicals, enzymes that can split the cellulose into the requisite glucose molecules and then the host simply absorbs those.

We are now able to bioengineer some little organisms that can do that. So now, when you look at the huge piles of beet pulp, look at the corn fields with all the corn fodder out there, people are saying, gee, look how much energy we could get from this agricultural waste. You can get it by burning it, or you can use it by making cellulosic ethanol from it. But, you know, topsoil is topsoil because it has organic material. It gives it tilth. Why does it have to be there? Because without the organic material, the soils can't hold the nutrients and they can't hold the water necessary for growing things. You can't grow plants in stone dust and you can't grow plants in sand. So you have to have organic material there. For a few years, we might be able to mine the organic material and still grow some crops, but there will be diminishing returns. I don't know steady state how much we can take.

Some people are euphemistic about how much we are going to get from sawgrass, prairie grass. They see it growing in huge amounts. But I suspect this year's prairie grass is growing because last year's prairie grass died and is fertilizing it. Now, we certainly can get something from this biomass, from agricultural waste and from growing trees and so forth, but it will not be enormous.

Let me give you some idea of what the challenge is. We use 21 million barrels of oil a day. Each barrel of oil has the energy equivalent of 12 people working all year. Hyman Rickover used data which showed the average family in 1957 used fossil fuel energy resulting in the equivalent of having 33, he said, full-time servants.

[Time: 22:30]

If you have some trouble getting your mind around this one barrel of oil and 12 people working all year, and by the way, that is costing you less than $10 per person per year, think how far a gallon of gasoline or diesel fuel, I appreciate the chart from the previous hour which showed how cheap oil was. It costs considerable less than water in the grocery store, by the way. But think how far that gallon of gasoline or diesel fuel carries your car and how long it would take you to pull the car there. And that gives you some idea of the challenge we face.

Another little example: if you are a strong man and work hard all day long, I will get more work out of an electric motor for less than 25 cents' worth of electricity. Now, that may be humbling to recognize that you are worth less than 25 cents a day in terms of fossil fuel energy, but that is the reality.

There are two publications. We have only a few moments remaining. I want to go quickly through some slides here. We have two major studies, one of them is a Corps of Engineers study and these first few slides will be from their study. The second one is the big SAIC study, commonly known as the Hirsch Report. I just want to read quickly some of the things they said. These are paid for by our government. They are out there. You may be asking the question, Gee, why aren't people talking about this and why aren't we doing something about it? Good question.

This is from the Corps of Engineers: the current price of oil is in the 45 to 57 per barrel range and is expected to stay in that range for several years. When they wrote this, by the way, it was about 65. Oil prices may go significantly higher, and some have predicted

prices ranging up to $180 a barrel in a few years.

Oil is the most important form of energy in the world today. Historically, no other energy source equals oil's intrinsic qualities of extractability, transportability, versatility, and cost. The qualities that enabled oil to take over from coal as the front line energy source for the industrialized world in the middle of the 20th century are as relevant today as they were then. And then this quote: In general, all nonrenewable resources follow a natural supply curve, getting more and more till you reach a peak and then falling down the other side. And they are concurring, a careful estimate of all the estimates lead to the conclusion that world oil production may peak within a few short years, after which it will decline. Once peak oil occurs, then the historic patterns of world oil demand and price cycles will cease.

And the last one from this source: Petroleum experts indicate that peaking is either present or imminent; will occur around 2005.

And now some charts from the Hirsch Report. This is very widely publicized. They concluded that we would have unprecedented risk management problems as we face the problem of transitioning from declining quantities of gas and oil and moving to alternatives. The economic, social, and political costs will be unprecedented. And then they state, We cannot conceive of any affordable government-sponsored crash program to accelerate normal replacement schedules. They said we should have started 20 years before peaking. If it is here, we are 20 years too late, aren't we?

And then this quote: The world has never faced a problem like this. There is a third report out there and that is by the Cambridge Energy Research Associates, and they believe that peaking will occur sometime in the future. And they present this little chart. This shows Hubbert's peak here, by the way, and because the actual data points didn't exactly follow his prediction, they are saying that you can't rely on his analysis. The little peak here, by the way, and the next chart will show us, that is from the Alaska oil find. Just a blip and the slide down the other side of Hubbert's peak.

And then in the couple of minutes remaining to us, the last slide we will have a chance to look at here. And this shows several predictions, depending upon whether you think the world will find enormously more oil than we now have found. And I will tell you that most of the experts that I have talked to believe we have found 95 percent of all the oil we will ever find. That is this curve. If you think we are going to double the amount of oil that we have now found, then that is this curve. And the one on top here, and by the way, they say that they don't believe in peaking, but they present this curve which shows peaking. This is unconventional oil.

Make up your own mind how much of that we are going to get, remembering the discussion we had earlier of the difficulty of getting this oil.

Mr. Speaker, we in the world face a huge challenge. I just returned from China. They are talking about post oil. They get it. I wish we did.

END

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Separately, Congressman Bartlett's Peak Oil Energy Conference held in Frederick, Maryland on September 26, 2005 was also taped by C-SPAN
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Transcripts of the texts of the speeches can be downloaded using the Thomas search engine from the House website: www.house.gov. The C-SPAN toll-free number to order video tape or DVD copies of floor speeches is 1-877-662-7726.