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UNDERSTANDING THE PEAK OIL THEORY

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND AIR QUALITY

OF THE

COMMITTEE ON ENERGY AND COMMERCE
HOUSE OF REPRESENTATIVES

ONE HUNDRED NINTH CONGRESS

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CONTENTS

	Page
Testimony of:	
Udall, Hon. Tom, A Representative in Congress from the State of New Mexico	10
Bartlett, Hon. Roscoe G., A Representative in Congress from the State of Maryland	24
Aleklett, Kjell, Professor, Department of Radiation Sciences, Uppsala University	32
Hirsch, Robert L., Senior Energy Program Advisor, SAIC	44
Esser, Robert, Senior Consultant and Director, Global Oil and Gas Resources, Cambridge Energy Research Associates	54
Additional material submitted for the record:	
Smith, Murray, Minister—Counsellor Government, Canadian Embassy:	
Testimony	62

UNDERSTANDING THE PEAK OIL THEORY

WEDNESDAY, DECEMBER 7, 2005

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ENERGY AND COMMERCE,
SUBCOMMITTEE ON ENERGY AND AIR QUALITY,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:35 a.m., in room 2322 of the Rayburn House Office Building, Hon. Ralph M. Hall (chairman) presiding.

Members present: Representatives Hall, Shimkus, Wilson, Sullivan, Murphy, Burgess, Barton (ex officio), Boucher, Green, Allen, and Solis.

Staff present: Mark Menezes, Chief Counsel for Energy and Environment; Maryam Sabbaghian, Majority Counsel; Peter Kielty, Legislative Clerk; David Vogel, Minority Research Assistant; and Bruce Harris, Minority Counsel.

MR. HALL. It looks like we have an unusual quorum this morning so we will get under way. The subcommittee will come to order.

Without objection the subcommittee will proceed pursuant to Committee Rule 4E, which governs opening statements by members and allows the opportunity to defer them for extra questioning time. I think we all have been through that and know what we are talking about. Hearing no objection, it is so ordered. Prior to the recognition of the first witness for testimony, any member when recognized for an opening statement may defer his or her three minute opening statement and instead have three additional minutes during the initial round of witness questioning.

So I will recognize myself for just a moment. I would like to thank our witnesses for being here today as we look at the theory of Peak Oil. We are having this hearing today to learn more about the theory, to hear different opinions, and to learn what we can do about it, if anything. While some theorists believe that we have reached our peak, the point at which the rate of world oil production cannot increase at any time, there are others that tell us that we are not going to peak any time soon, and others who still believe oil is continuously being created and will therefore never peak.

We have not been ignoring a possible peak in oil production and this energy bill that was signed into law in August had provisions that address oil usage by promoting conservation and, in addition,

conventional and unconventional production. One provision in particular that I was proud of that I sponsored was the Ultra Deep Water and Unconventional Onshore Research and Development Program. In the Continental U.S. there are significant amounts of oil and natural gas in the ground and beneath the seabed that cannot be produced due to limits on technology. So this amendment is probably more of a research and development amendment than it is an energy amendment, but they fit well together. The Ultra Deep Water and Unconventional Nitro Gas and Petroleum R&D Program is a fast paced technology lead by industry and academic groups with Government and industry cost sharing. Taking some advance technologies off the shelf and accelerating the development of others could lead to increased domestic oil and gas production within maybe three years.

According to analysis by the Energy Information Administration, the program will increase production of natural gas by 3.8 trillion cubic feet, oil by 858 million barrels, and Federal royalties in more than sufficient amounts to pay for the effort and lower the price of both fuels. I do not know of a better deal than that. We are not talking about tax money; we are talking about being paid by royalties that we know are there. If we can get them up and carryout this program properly to pay back the funds that the Federal Government sets forth and shows that private industry does work. I do not know of a more acceptable thrust than that to help solve our energy dilemma. An analysis by the Bureau of Economic Geology at the University of Texas concludes that investment in technologies to develop new gas resources will result in a substantial net increase in royalties back to the Government. I am still waiting for them to tell us how much, when, and how quickly that is going to happen.

Whether or not we are reaching our peak, it seems responsible to continue in the vain we are going in by continuing to work on ways to conserve energy while increasing our domestic supply of oil and using research to develop substitutes for conventional oil. I think that both opponents and proponents of the Peak Oil Theory have interesting things to say and valid points to make. Therefore, I am looking forward to hearing our witnesses' testimony and to the ensuing discussion.

We have good witnesses today and two Members of Congress that have given of their time and their ability to bring us some information. We will recognize them in just a moment.

[The prepared statement of Hon. Ralph M. Hall follows:]

PREPARED STATEMENT OF HON. RALPH M. HALL, CHAIRMAN, SUBCOMMITTEE ON ENERGY AND AIR QUALITY

The Subcommittee will come to order. Without objection, the Subcommittee will proceed pursuant to Committee Rule 4(e), which governs opening statements by Members and the opportunity to defer them for extra questioning time.

Hearing no objection, prior to the recognition of the first witness for testimony, any Member, when recognized for an opening statement, may defer his or her three-minute opening statement and instead have three additional minutes during the initial round of witness questioning.

The Chair recognizes himself for an opening statement.

I would like to thank our witnesses for being here today as we look at the theory of peak oil. We are having this hearing today to learn more about the theory, to hear different opinions, and to learn what we can do. While some theorists believe that we could reach our peak – the point at which the rate of world oil production cannot increase – at any time, there are others who tell us that we are not going to peak anytime soon, and others still who believe that oil is continuously being created and will therefore never peak.

We have not been ignoring a possible peak in oil production. In the energy bill that was signed into law in August, we had provisions that address oil usage by promoting conservation and additional conventional and unconventional production. One provision in particular that I sponsored is the ultra-deepwater and unconventional onshore research and development program. The continental U.S. has significant amounts of oil and natural gas in the ground, and beneath the seabed, that cannot be produced due to limitations on technology. The Ultra-deepwater and Unconventional Natural Gas and Petroleum R&D program is a fast-paced technology program led by industry and academic consortia with government and industry cost sharing. Taking some advanced technologies off the shelf, and accelerating development of others could lead to increased domestic oil & gas production within 3 years. According to an analysis by the Energy Information Administration, the program will increase production of natural gas by 3.8 trillion cubic feet and oil by 850 million barrels, increase Federal royalties in more than sufficient amounts to pay for the effort, and lower the price of both fuels. An analysis by the Bureau of Economic Geology at the University of Texas concludes that investment in technologies to develop new gas resources will result in a substantial net increase in royalties back to the government.

Whether or not we are reaching our peak, it seems responsible to continue in the vain we are going in by continuing to work on ways to conserve energy while also increasing our domestic supply of oil and using research to develop substitutes for conventional oil. I believe that both opponents and proponents of the peak oil theory have interesting things to say and valid points to make and therefore am looking forward to hearing our witnesses' testimony and to the ensuing discussion.

With that I yield back the balance of my time.

MR. HALL. At this time, I recognize Mr. Green of Texas for an opening statement.

MR. GREEN. Thank you, Mr. Chairman.

And our real ranking member Congressman Boucher has a conflict this morning and so I am here, but those of you who are testifying, I bet it is terrible to see two Texans up here running the committee today when we talk about losing our potential for oil.

I am glad the chairman and the ranking member called this hearing and I welcome our respected witnesses, all of them, particularly our colleagues both from New Mexico and from Maryland.

The oil and gas industry has been life bud and part of the entity of our home State of Texas for over 100 years. So when experts say the world has run out of oil, we tend to get a little nervous because Texans work in oil fields around the world and may of the best exploration companies are headquartered in Houston. I think the oil companies know the energy companies recognize that they are not really oil or gas companies, they are really energy companies so a great many of them have changed their name to energy companies. So I think they recognize that we need energy from whatever source, whether it is oil or gas or some other source.

However, after several decades of predictions, many of the so-called peaks have come and gone and global oil exploration has in fact increased, not decreased, due to a variety of factors. Many oil fields and gas fields around the world are off limits due to the variety of governmental policies or dangerous conditions. Other fields like Siberia and Alaska were originally thought to be remote and inhospitable but now in the industry's mainstream. Other fields like Canadian Oil Sands or Venezuela Heavy Oil were previously uneconomic but now are becoming mainstream products. For example, my district includes a Lyondell-CITGO Refining in Pasadena, Texas, the largest heavy crude refinery in the United States which was rebuilt to specifically handle Venezuela and heavy crude.

Conventional oil technology has also improved in the last 25 years so we are able to reach deep water oil previously uneconomic and to produce and in much more environmental friendly manners. So I hope believers in Peak Oil will forgive some of us from thinking that they sound like a little boy that cried wolf, however, I will not forget the fable that the wolf does show up in the end. As a result, I want to do our best to make sure we prepare for if it really is a Peak Oil with an open mind.

Furthermore, it is comforting to know that energy information agencies predict peak oil around 2050, which is not exactly right around the corner, with fuel cell prototype cars in production it looks like we have time to adapt to the new energy economy. Also with prices staying high or rise, this effect will further accelerate the development of alternative energy technologies, however, the transition in the next energy economy will be painful in the short and immediate term especially to low income individuals like many of my constituents because energy costs are regressive. Poor people pay more as a percentage or their income on energy than wealthy people do. If we want to prevent people from losing their health insurance, their car, their house, their apartment due to high energy costs, they cannot avoid--we must avoid Federal policies across many issues that address some of these costs, other costs for lower income Americans.

The real risk is probably not that we will wake up one day and the global gas tank will be empty, but that working people will not have the ability to manage the transition to the next energy economy which will be an intrinsic process.

Again, thank you, Mr. Chairman and I yield back.

MR. HALL. The chair recognizes the gentleman from Illinois, Mr. Shimkus.

MR. SHIMKUS. Thank you, Mr. Chairman.

I want to welcome our two colleagues here and really appreciate their focus on a debate that the public wants to know about. So I know they come in sincerity and information is always good and we can sort through the issues here.

In July, as everyone knows, we passed the Energy Policy Act and part of that was addressing the concern of our alliance in foreign oil. We have done this numerous times. We address some of those issues in the Energy and Policy Act. Of course everyone knows my focus on renewable fuels. With the ethanol and soy diesel debate and expansion is quite phenomenal. I talked about it in committee all the time. In the last Congress, I had a flexible fuel vehicle, a Ford Taurus, but I did not have a single retail location to get 85 percent ethanol. Now I can go all throughout my district. And in one small community, Harrisburg, there is four different retail locations that sell 85 percent ethanol. I drive a Ford Explorer that is a flexible fuel vehicle and of course Ford had just come out with a major announcement of their plan to expand their line of flexible fuel vehicles in response to this issue of one, where are our fuel sources coming from in the future, also, the aspect to decrease our reliance on foreign oil and look at the renewable arena.

The State of Illinois has a tax credit that has allowed many of the major road, over the road trucking companies to go with a fuel mix of 11 percent of biodiesel and that could be soy diesel that could be reformulated cooking oil that burns cleaner. So we have made some great progress. In fact, in the recent Forbes.com article, California and the West Coast is finally getting engaged. Even so I am going to quote this, Microsoft's cofounder Bill Gates seems to want a piece of the action when it comes to renewable energy. The billionaire's investment company, Cascade Investment, has agreed to invest $84 million in Pacific ethanol which will help it finance construction of several planned fuel additive plants on the West Coast. Cascade's investment gives Gates 27 percent stake in Pacific ethanol.

So we have made great progress. And I think it is important for the public to understand the challenges of the future but also that we have not sat empty and not have addressed any of this. The other thing that I hope we talk on and I will ask the question to Roscoe after his opening

statement is about the ability of BTU conversion. The country has 250 years of BTU ability based upon our coal resources. BTU conversion is age old technology from World War II. I know Roscoe is very knowledgeable of Fisher Tropes technology and the ability to turn coal into fuels. And at the supply and demand issue, Economics 101 when we have limited supply, higher demand, prices go up, coal or liquid technology probably turns profitable around $35 per barrel which is where we are at. And so what do we see? We see Soso, a South African Company that has this technology looking at locations within the United States to do this BTU conversion. And that is the way the market should work and that is what the market does.

And so we want to continue to encourage that and look at policies to address this wherever this timeline is in the future to make sure that we can as an economy and as a country and a lot of it because of national security to make sure that we are not caught unaware. So I applaud this hearing. I think we have made some great strides, Mr. Chairman, in the Energy Bill but it is never harmful to look to the future and see what else we can do to make sure that we have the ability to meet our demands.

On a point that my colleague, Mr. Green mentioned, of course, on energy issues we are pretty similar and we work very, very hard. Illinois, a southern part of the State of Illinois, my district is a huge, used to be a huge oil producing part of the Nation. Now it is still halfway decent. We have the largest operating well definitely in the Midwest and mostly in the Continental United States based upon new technology. It produces a million barrels a year and it drills underneath a State wildlife refuge with new technology. So to my colleague's comments new technologies are going to help address some of the immediacy but there are reserves based upon the cost of a barrel that we now can get active if we address the other issues and environmental concerns that I think we can through new technology so I applaud this.

Thank you, Mr. Chairman, I yield back my time.

[Additional statements submitted for the record follow:]

PREPARED STATEMENT OF HON. JOE BARTON, CHAIRMAN, COMMITTEE ON ENERGY AND COMMERCE

I would like to begin by welcoming our witnesses and thanking them for their time today. I would especially like to welcome the Congressman Roscoe Bartlett from Maryland and Congressman Tom Udall from New Mexico. I asked Chairman Hall to hold this hearing on the "peak oil" theory at Congressman Bartlett's request. Congressman Bartlett is an active and persuasive advocate for peak oil theorists and I look forward to hearing his views and perspectives on peak oil and in particular on his House Resolution Number 507.

I have been involved in the energy industry for much of my career and the argument that oil is a finite resource is not new for me, nor is it new to the energy industry as a whole. The themes underlying "peak oil" have circulated ever since the first oil well

began production in Pennsylvania in 1859. The current views on the topic cover a wide spectrum and I think that it is important that we are having this hearing. Some say we have peaked, some say we are about to peak, some say any peaking is years in the distance and some even say that we may never peak.

One fact is certain, the more we have been able to explore, the more we know. For example, in 1974, natural gas resource estimates in moratoria areas off the Atlantic and Pacific coasts were approximately equal to Gulf of Mexico resource estimates. Since then, from the areas where we have had access in the Gulf, we have already produced more than 3 times the 1974 estimates and the latest government estimates are that almost five times as much gas still remains to be produced in the Gulf. Even with this success, production off the Atlantic and Pacific coasts remains politically charged.

Another bright spot for production comes from our neighbors to the North. Many oil resource tabulations exclude "unconventional" resources or sources of oil other than conventional crude. The Canadian tar sands are considered an "unconventional" resource. Yet there is nothing wrong with oil being recovered unconventionally, and because of research and investment into this "unconventional" resource, a once 1.3 million barrels per day area is projected to become a 5 million barrel per day by 2030. That's a record to be very proud of and I am glad that Mr. Murray Smith from the Canadian Embassy will be here to explain to us the development of the Albertan tar sands.

I'm hopeful that the United States will be able to follow suit with its shale oil reserves. The United States shale oil resource base is tremendous. EIA estimates that the United States alone holds 2 trillion barrels of this resource. Technologies are being developed to make this resource economical to produce and there is a provision in the Energy Policy Act of 2005 that directs the Secretary of the Interior to ultimately establish a shale oil production program. Once the shale oil production technologies have reached commercial maturity (like tar sand technologies that have NOW made Canada's crude oil resource base prolific), our crude oil resource base would actually dwarf the reserve estimates of countries like Saudi Arabia.

Treating oil as a finite resource is the responsible thing to do, but just because oil may be a finite resource, doesn't mean we should stop searching for it, or stop developing better technologies and producing it. A piano has a finite number of keys, but musicians don't stop coming up with new songs because some good songs have already been sung. The Energy Policy Act of 2005 makes strong strides toward the right solution with policies promoting conservation, research and alternatives. Again, the more we explore and develop technologies, the more our energy resource base will grow.

I thank all of the witnesses again for their time today. I look forward to hearing your perspectives.

MR. HALL. I thank you.

And we have for the first panel today two of our very own and at a time when there is a lot of rancor up here, I think it is good to see that Republicans and Democrats can work together. These two gentlemen have led the House Peak Oil Caucus and have introduced House Resolution 507. Roscoe Bartlett, my neighbor upstairs, is a professor and I can just imagine what kind of student he was that ruined the curve for everybody around him. I never did like anybody like that, but I always respected them. He is a research scientist, investor, small business owner, and a farmer, an unusual farmer in that he is a successful farmer. He has got, I do not know how many grandchildren, but

everybody in his family is involved in the operation and in the dignity of work on that farm. I think we could all tear a page out of his book. One of three scientists, I do not know how many scientists you need in a Congress, but he is one of three, and we are happy to have him.

Tom Udall, of a great family, is serving his fourth term in Congress. I am impressed by his résumé. He serves on the House Resources, Small Business, and Veterans Affairs Committees. He was New Mexico's Attorney General, the first, I am told in a long, long time, if not ever, to serve two consecutive four year terms as attorney general; so very a responsible position. He is of the Udall family. When I first came to Congress 25 years ago, Moe Udall was just across the hall from me and I learned more from him than I did all the years I was in law school and the years I was in the Texas Senate and on the bench. Moe taught me more in a week than they had in all that time. He was a great man and a great family so we are anxious to hear from you.

Then I think the request has been made that you all join the group in questioning the other. And I have had a request from both of you not to allow the other one to interrogate each other for you to so we will not allow that to happen but you come on and join us here when we have the second panel.

At this time, we will recognize Mr. Udall. We go on youth to start with. You are recognized for as much time as you take, but be reasonable.

STATEMENTS OF HON. TOM UDALL, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW MEXICO; AND HON. ROSCOE G. BARTLETT, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MARYLAND

MR. UDALL. I will, Chairman Hall. Thank you for your very generous comments and Representative Shimkus, Representative Green, good to see you here today, and thank you for having us.

We appreciate very much you holding a hearing on this important and urgent matter of Peak Oil. Mr. Bartlett and I started the House Peak Oil Caucus to bring immediate and serious attention to this issue. The continued prosperity of the United States depends on the Nation taking immediate and intelligent action concerning Peak Oil.

I have had a chance to review the testimony of my colleague, Mr. Bartlett, and also that of Mr. Aleklett and I agree with their analysis that the peak in oil production will occur in the next two decades and potentially as early as 2010. The central theme here is there is not much time to act. Today, I would like to use my time to stress how important it

is for the United States to take a bold, new approach to our energy supplies.

Our economy and way of life is dependent on cheap oil. In many ways, cheap oil is responsible for our prosperity. Since oil provides about 40 percent of the world's energy, a peak and global oil production will be a turning point in human history. Oil and natural gas literally transport heat and feed our country. Therefore, we must act immediately to diversify our energy supplies and mitigate the economic recession and social and political unrest that will undoubtedly accompany the peak in oil and natural gas production if we do not act.

The United States' demand for oil continues to increase by about 2 percent per annum. Furthermore, a global demand has increased faster than production and the once substantial cushion between world oil production and demand has decreased. This phenomenon has increased the price of oil and consequently huge amounts of American money up to $25 million per hour goes abroad to pay for foreign oil. And as many people have now become increasingly aware, some of this money goes to governments and groups who are considered a threat to our national security. Middle Eastern Countries flush with oil dollars help fuel the terrorism we are fighting. Some say that market forces will take care of the Peak Oil problem. They argue that as we approach or pass the peak of production the price of oil will increase and the alternatives will become more competitive.

However, no currently available alternative is anywhere near ready to replace oil in the volumes we use it today. Once more, even today's oil prices do not accurately reflect the full social costs of oil consumption. Currently in the United States, Federal and State taxes add up to about 40 cents per gallon of gasoline. A world resources institute analysis found that fuel related costs not covered by drivers are at least twice that much. The current price of oil does not include the full cost of road maintenance, health, and environmental costs attributed to air pollution, the financial risk of global warning, or the threats to national security. Without these externalities in the market, significant private investment in alternative technologies will not occur.

Over the past 100 years, fueled by cheap oil, the United States has led the revolution in the way the world operates. Replacing this resource in a relatively short time is not only an incredible challenge, but also imperative to the survival of our way of life. The United States has faced such challenges in the past and responds to great challenges and inevitable threats. We pooled our resources and ingenuity to build an atomic bomb in just a few years and put a man on the moon in a decade. We can and must do this again. We must commit to a bold, new initiative.

To eliminate our dependence on foreign oil and develop a new economy based on clean, renewable non-polluting energy, we need a massive long-term investment in research for both basic and applied science similar in scope to past successful investments. We must produce effective policies that create a new generation of scientists devoted to changing the way we produce energy. We must also commit to decreasing our demand for oil. We can start by increasing efficiency. The United States consumes 25 percent of the world's oil. Of that 25 percent, two-thirds is used for transportation. Hence, trans-portation in the United States accounts for 16.5 percent of the world's oil consumption.

It is obvious that more efficient transportation is one of the keys in reducing our demand for oil. Transporting goods and people by rail is at least five times as efficient as automobiles. Therefore, we must revive and reinvest in our passenger and freight rail system. A modest increase in fuel efficiency of our automobile fleet from 25 miles per gallon to 33 miles per gallon using existing technology would decrease our demand for oil by 2.6 million barrels a day or about 1 billion barrels a year. However, the turnover rate for the automobile fleet is 10 to 15 years, therefore, we must start immediately.

Simple, everyday things like automobile maintenance also increase efficiency. According to the Department of Energy, proper inflation of car tires can increase fuel efficiency by 3 percent, translating to the equivalent of 100 million barrels of oil per year. The buildings in which we work and live are terribly inefficient. We could easily reduce their energy consumption by one half. We must immediately weatherize and make more energy efficient tens of millions of buildings. Our bold new initiative must instill these ideas in the American consciousness.

The sooner we start the smaller our sacrifices will be. These tasks will not be easy but I am confident that we will achieve our goal for we have little in the way of alternatives.

Thank you, Mr. Chairman and I will be happy to respond to questions.

[The prepared statement of Hon. Tom Udall follows:]

PREPARED STATEMENT OF HON. TOM UDALL, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW MEXICO

Mr. Chairman, Ranking Member Boucher and members of the Energy and Air Quality Subcommittee, I thank you for holding a hearing on the important and urgent matter of Peak Oil. Mr. Bartlett and I started the House Peak Oil Caucus to bring immediate and serious attention to this problem. I hope that this hearing will be the start of many such discussions that will ultimately lead to legislative action to mitigate this inevitable crisis.

The theory of Peak Oil states that, like any finite resource, oil will reach a peak in production after which supply will steadily and sharply decrease. In 1956, Shell Oil geologist M. King Hubbert predicted that oil production in the contiguous United States would peak in about 1970 and be followed by a sharp decline. At the time, many dismissed his predictions as false, but history shows they were remarkably accurate. A growing number of geologists, economists and politicians now agree that the peak in the world's oil production is imminent; predicted to occur within one or two decades. Some disagree with this prediction, calling it a doomsday scenario and say that technological advances will buy us more time before we reach peak production. Theirs, however, is not the consensus view and even they agree that a peak in the world's oil production is inevitable. I am here today to stress how important it is for the United States to take action concerning our oil and natural gas supplies. Our economy, and way of life for that matter, is currently dependent on cheap oil. Oil and natural gas literally transport, heat and feed our country. Therefore, we must act immediately to prepare for and mitigate the economic recession and social and political unrest that will undoubtedly accompany the upcoming peak in oil and natural gas production.

The strongest evidence that the peak in world oil production is imminent is that for the last thirty years, production of oil has exceeded discovery of new oil resources. The reason for this is relatively simple. Oil is a limited commodity and the large oil fields with easily extractable resources were naturally the first ones to be exploited. These fields were found thirty or forty years ago in the Middle East (Saudi Arabia, Iraq, Iran and the United Arab Emirates) and are still the main suppliers of the world's oil. As the finite supply of oil in these deposits diminishes, exploration for new supplies continues. However, new discoveries tend to be small and rapidly exhausted, making them less economically viable.

Meanwhile, global demand for oil, which is at an all time high, continues to rise. The United States demand continues to increase by about 2% per annum. Also, with the globalization of the market economy and increases in oil-driven industrial production in Asia, new consumers are contributing to rising demand. To meet rising demand oil companies must increase production, accelerating us towards the peak. Demand has increased faster than production and the once substantial cushion between world oil production and demand has decreased. This phenomenon has increased the price of oil and consequently huge amounts of American money, up to $25 million per hour goes abroad to pay for foreign oil. And as many people have now become increasingly aware, some of this money goes to governments and groups who are considered a threat to our national security.

The United States only possesses 2% of the world's oil reserves and only produces 8% of the world's oil capacity. Therefore, we are not in a position to control the world's oil production. However, we can significantly decrease demand. The United States consumes 25% of the world's oil. Of that 25%, two-thirds is used for transportation. Hence, transportation in the United States accounts for 16.5% of the world's oil consumption. It is obvious that more efficient transportation is the key in reducing our demand for oil. For example, a modest increase in fuel efficiency of our automobile fleet from 25 miles per gallon to 33 miles per gallon using existing technology would decrease our demand for oil by 2.6 million barrels a day or about 950 million barrels per year. These simple changes would account for a significant percentage of the oil we import each year. However, the turnover rate for automobiles in our country is 10-15 years. This means we must start immediately to avoid reaching the peak in world oil production before actions such as higher CAFE standards make a difference.

Some say that market forces will take care of the peak oil problem. They argue that as we approach or pass the peak of production, the price of oil will increase and alternatives will become more competitive. Following this, consumers will act to replace our need for non-petroleum energy resources. This philosophy is partly true. However,

the main problem with this argument is that current U.S. oil prices do not accurately reflect the full social costs of oil consumption. Currently, in the United States, federal and state taxes add up to about 40 cents per gallon of gasoline. A World Resources Institute analysis found that fuel-related costs not covered by drivers are at least twice that much. The current price of oil does not include the full cost of road maintenance, health and environmental costs attributed to air pollution, the financial risks of global warming from increasing carbon dioxide emissions or the threats to national security from importing oil. Because the price of oil is artificially low, significant private investment in alternative technologies that provide a long-term payback does not exist. Until oil and its alternatives compete in a fair market, new technologies will not thrive.

Oil is a very powerful resource with an incredibly high energy density. For example, the energy in just one barrel of oil is equivalent to eight people working full time for a year. Over the past 100 years, fueled by affordable oil, the United States has led a revolution in the way the world operates. For example, petroleum-based fertilizers are used to inexpensively grow remarkable amounts of food and airline transportation allows us to reach virtually anywhere in the world within 24 hours helping to create a global economy. However, the sustainability of the oil-based economy is rapidly decreasing. Reaching a peak in oil production has the potential to destroy our economy and cause great social and political unrest. Also, the carbon released using fossil fuels is contributing to dramatic changes in the earth's climate. Therefore, replacing this resource in a relatively short time is not only an incredible challenge but also imperative to the survival of our way of life. The United States has faced such challenges in the past. In response to great challenges and imminent threats, we pooled our resources and ingenuity to build an atomic bomb in just a few years and put a man on the moon in a decade. We can and must do this again.

To reduce and potentially eliminate our dependence on foreign oil and develop a new economy based on clean, renewable energy, we need a major investment in research for both basic and applied science similar in scope to the ones we have made in the past. We must develop and implement policy immediately that inspires our citizens to make sacrifices now that will ensure our future prosperity. The sooner we start, the smaller those sacrifices will be. We must produce effective policies that create a new generation of scientists devoted to changing the way we produce energy. These tasks will not be easy, but I am confident that we will achieve our goal, for we have little alternative.

Thank you once again for holding this hearing and inviting me to testify. I welcome any questions the committee may have.

MR. HALL. Well thank you, Mr. Udall.

Mr. Bartlett, I recognize you, sir.

MR. BARTLETT. Thank you very much, Mr. Chairman. I want to thank you very much for holding this hearing.

I have a few PowerPoint slides. Could we have the next one please?

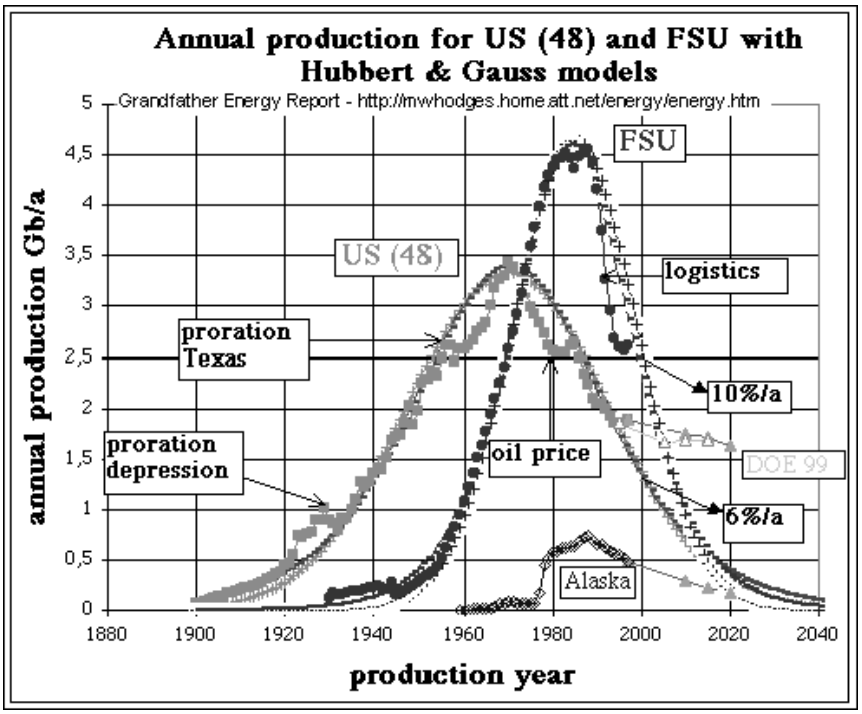
- 2% of World Oil Reserves
- 8% of World Oil Production
- 5% of World's Population

■ US Consumes 25% of World's Production
- 2/3 Imported

These are some data that inspired 30 of our leading citizens, Boyden Gray, McFarland, Jim Woolsey, and 27 others including a lot of retired four star admirals and generals to write a letter to the President saying Mr. President, the fact that we have only 2 percent of the known reserves of oil and we used 25 percent of the world's oil and import nearly two-thirds of what we use is a totally unacceptable national security risk. We need to do something about that.

I would submit that if you do not believe that there is such a thing as Peak Oil, you need to understand that this really is a big national security risk. And the things that we need to do to transition to alternatives so that we are not so dependent on foreign oil are exactly the same things that we need to do to attenuate the affects of Peak Oil.

These data, by the way, the significant thing, we have only 2 percent of the world's oil reserves but we are producing 8 percent of the world's oil which means that we are pumping our oil roughly four times faster than the rest of the world. We are really good at pumping oil. These data encourage me to be for the moment opposed to drilling in ANWR and offshore. And the reason for that is if we have only 2 percent of the known reserves of oil, I am having a lot of trouble understanding how it is in our national security interest to use up that little bit of oil we have as quickly as possible. If we could pump the offshore oil and ANWR oil tomorrow, what would we do the day after tomorrow? And there will be a day after tomorrow. This may be a rainy day. I think there is going to be a rainier day and I would like to husband these resources for that rainier day. This is very much like having money in the bank that is yielding really high interest rates. If you have money in the bank yielding really high interest rates, you probably would leave it there and that is what I think we need to do for the moment with this oil.



The next slide please. To put this discussion in context, we really need to go back about six decades to the mid-‘40s and ‘50s. A scientist in the Shell Oil Company M. King Hubbert looking at oil fields, their exploitation and exhaustion. He noted that they all tended to follow a rough bell curve and he theorized that if he could add up all those little bell curves he would have one big bell curve where he could predict when we would reach our maximum production in this country. He would have to, of course, guess at the amount of oil we were going to find in the meantime. He made a prediction in 1956 that we would peak at about 1970 and then the slide here, you see the smooth green curve was his prediction, the more ragged larger symbol green curve were the actual data points. And you see that they pretty faithfully followed his prediction. We are now about halfway down what many people call Hubbert’s peak. The red curve there is the Soviet Union. And you see that they kind of fell apart after they reached their peak and as a result of that, they didn’t reach their potential so they kind of have another. And they were just about now over their second little peak on the way down the other side of Hubbert’s peak.

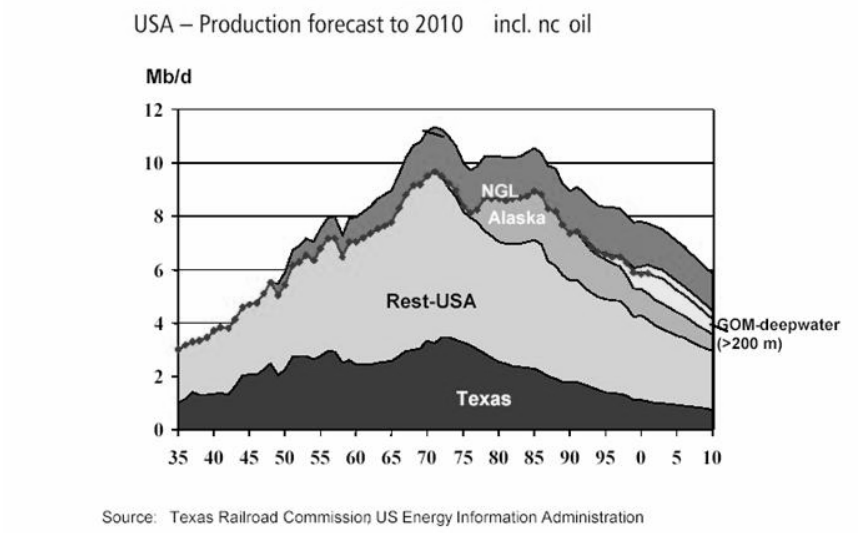


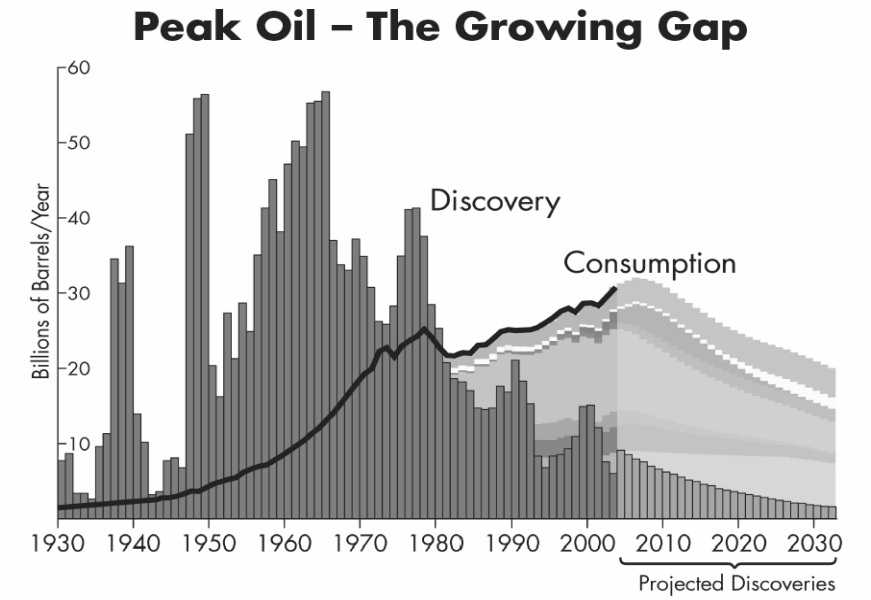
Figure 4: The future oil production profile for the declining oil regions of Texas and Rest of the USA is controlled simply by the physics of depletion, allowing a straightforward extrapolation of existing trends.

The next slide shows where we get oil from in our country and notice how big Texas is there. It has been a big contributor to oil in our country. And notice that we did reach maximum oil production in 1970. And in spite of Prudhoe Bay which produced for a while about a fourth of the oil that we were pumping in our country, it has been pretty much downhill just a small blip for Prudhoe Bay and then downhill ever after that following down the other side of Hubbert's peak.

I remember and I am sure you do, Mr. Chairman, the fabled Gulf of Mexico oil discovery that was supposed to solve our oil problem for the foreseeable future. That is the little bit of yellow here. It really is not all that big. That is all the contribution that it made. The observation is made that we are not running out of oil that is true. There is still a lot of oil there. As a matter of fact, worldwide there is probably about half the oil there yet to be recovered than we have recovered so far.

The same M. King Hubbert that predicted that we would peak in 1970 and he was correct there, predicted that the world would peak about now if you factor in the Arab Oil Embargos and a deep worldwide recession as a result of oil price spike hikes. If M. King Hubbert was right about our country, why shouldn't he be right about the world? And we have known for at least 25 years that M. King Hubbert was right about our country. By 1980 when President Reagan came to office, we were already ten years down the other side of Hubbert's peak and we knew very well that we were sliding down Hubbert's peak. The response to

that observation was to drill more wells. We drilled more wells but really did not find anymore oil. You cannot find what is not there. You cannot pump what you have not found.



The next slide which is on the screen now shows two curves and they are superimposed the big bar graph curve is the discoveries of oil and you notice that the discoveries of oil occurred 30, 40 years ago. And notice for the last two and a half decades really that there has been an ever decreasing discovery of oil. Since the early 1980's, we have been using more oil than we have found. And that solid black line represents the consumption. Now those who are used to looking at curves, it is obvious that you cannot pump more oil than you have found. And so all the oil that we can pump from now on in addition to what is projected here that we will find, we could find more, we could find less. But all the oil that we can pump from now on is going to have to come from additional oil that we find or the reserves that we have not yet pumped.

And the curve under the discovery cannot be greater than the curve under consumption. Now if we have enhanced oil recovery and we can recover it more quickly. All that is going to mean is that we are going to reach a higher peak a little later but since there is no more total oil available, if you do not make more oil available by the enhanced recovery, all you will do is change the shape of that down slope and you will fall off the other end more quickly.

Mr. Green mentioned the wolf, wolf and thank you very much for mentioning that. We have cried wolf, wolf several times in the past but in the parable, you know, the wolf did come. I think he ate all the sheep

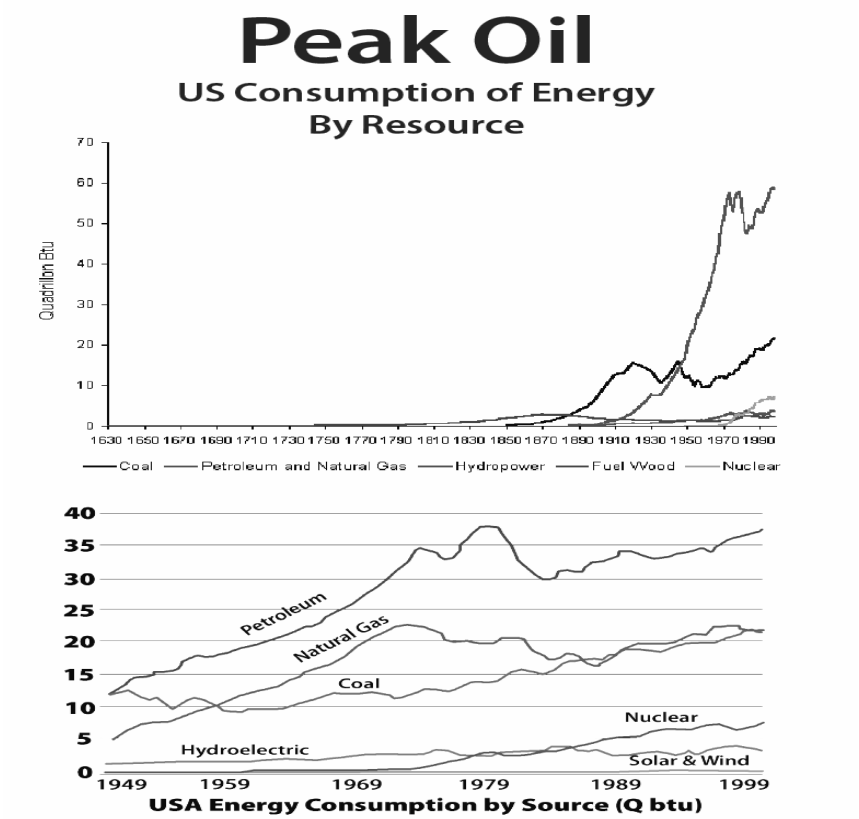
and the people. Is that correct? So one day the wolf will come and that is what we are trying to do is to avoid the kind of catastrophe that they had in the parable.

When we are looking at replacing these fossil fuels we have been using, you have to look at energy profit ratio. We are now producing oil from the oil shales in Canada at about $30 a barrel, maybe less than that when it is selling at $60. That is really a good dollar profit ratio. But I understand that they are now using more energy from natural gas than they get out of the oil they produce. So the energy profit ratio is negative. That is a good thing for them because they got a lot of gas, it is cheap, it is hard to transport to other places and oil is in high demand and they can sell it for twice the production cost so that makes a lot of sense. But at the end of the day with the limited energy resources in the world, we really should not be producing energy with a negative energy profit ratio.

I would just like to make a couple observations about exponential growth and that is where we are. Albert Einstein said that that was the most powerful force in the universe, the power of compound interest. My friend, no relative of mine, but if you have not heard Dr. Albert Bartlett's Hour Lecture on Energy, pull it up and read it. It is the most interesting one hour lecture I have ever heard. He gives, really, he gives two examples in there of exponential growth which gives us some feeling as to the power of exponential growth. One was the discovery of the chessboard in an ancient kingdom and the king was so pleased with that that he told his subject, I will give you any reasonable thing you ask for as a reward for inventing the chess, the game of chess. And the inventor said, Mr. King, I am a very simple man, I have very simple needs. If you will simply take my chessboard and put one grain of wheat on the first square and two gains of wheat on the second square, and four on the third square and keep doubling the amount of wheat you put on each square of the chessboard, that is all the reward I will need for inventing chess. And the king thought stupid fellow, I would have given him something really meaningful and all he asked for is a little bit of wheat on his chessboard. Had he been able to do that, I understand that that would have been the total world harvest of wheat for 40 years. That is the power of exponential growth.

Albert Bartlett gives another really interesting little example and it really relates to our situation with oil. There are some microbes living in a one-liter flask and these microbes, they reproduce very quickly and so in one minute they double the number of them. And the leaders of this little colony of microbes looks around and says gee, you know, with this growth rate, we are going to outgrow this flask and so we need to be looking for some additional flasks. So they send out scouts and they are

very successful. They find not one or two but they find three additional flasks. We now have four times the territory to expand in that we have now. If they were to fill the first flask by midnight and they are doubling every minute, they have filled the second flask by one minute after midnight and they fill the third and fourth flasks by two minutes after midnight. This shows the exceptional power of compound growth.

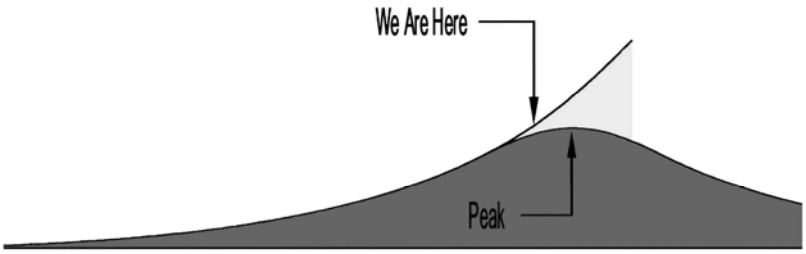


The next slide is one that I would like to spend just a moment on because--the top one. The bottom one by the way, we have split out natural gas and oil, otherwise it is the same as the upper slide. And we are looking at only a relative few years. What we do here to look back through history when the industrial revolution first started with the brown line there which is wood and it was stuttering of course when we found coal. And then we found oil and look what happened. And the ordinate here is quadrillion BTU's and the abscissa, of course, is time. I would just like to note that the population curve of the world roughly follows the curve for oil here. We started out with about a billion people and now we have about 7 billion people almost literally eating oil and gas because of the enormous amounts of energy that go into producing

food. Almost half the energy that goes into producing a bushel of corn comes from the natural gas that we use to produce the nitrogen fertilizer.

Just a comment or two about energy density and how difficult it is going to be to replace oil. And by the way, we have been about 100 years into the age of oil. In another 100 years or so, we will be through the age of oil. In 5,000 years of recorded history, 200 or 300 years is just a blip, just a tick in the history of man. We found this incredible wealth under the ground. And rationally what we should have done as a civilization when we found that is to ask ourselves what will we do with this incredible wealth to do the most good for the most people over time. And when you--it really was incredible wealth because every barrel of this oil has enough energy in it to do the work output I have seen eight, I think the number usually given, it represents about 50,000 man hours of effort for one barrel of oil. And that is the equivalent of having 12 people work all year for you. That is the amount of work you get out of one barrel of oil. And today at the pump with gas prices about $2, it costs you, 42 gallons costs you less than $100. That is incredible.

If you have some trouble getting your arms around that, imagine how far that one gallon of gas, still cheaper than water in the grocery store. It was cheaper at $3 a barrel than small bottles of water in the grocery store, how far that gallon of gas or diesel takes your car or truck and how long it would take you to pull it there to get some idea of the energy density. Now you can't pull it maybe but with a come-along and fence, you know, tree or guardrail you could get your car the 20 or 30 miles that it would take. And how long would it take you to get it there? If you go out, Mr. Chairman this weekend and work really hard in your yard all day, I will get more work out of an electric motor with less than 25 cents worth of electricity. That gives us some--that may be kind of leveling but that gives you some idea as to the incredible energy density in these fossil fuels. What wealth it was we found under the ground. And almost like children who found the cookie jar, we had no restraint. We tried to use it up as quickly as we could use it up. And there will be an age of oil. One day there will be no more economically feasible recovery of oil, gas, and coal.



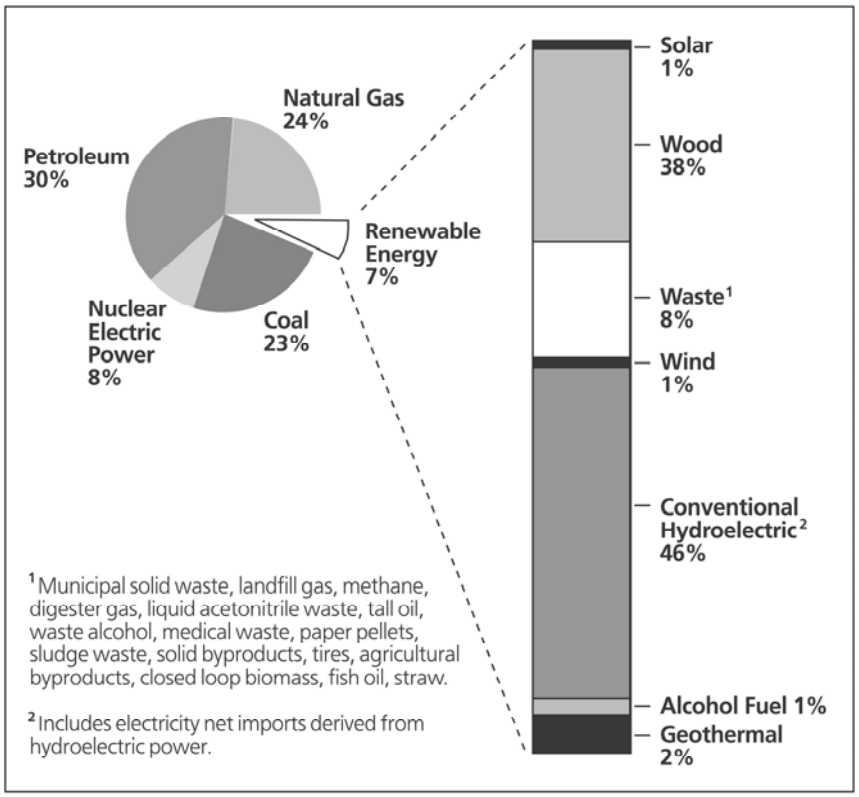
The next slide is a schematic which shows and I would like to change one little thing. I am not sure where we are but notice--well this is a 2 percent exponential growth curve and the yellow area represents 35 years because at 2 percent exponential growth, you double in 35 years and on the ordinate here, the top of the yellow is twice as high as the bottom of the yellow. I think that we are probably there. And notice that the problem starts before you reach peak because this exponential growth and this is just 2 percent exponential growth by the way. China is now growing nearly 10 percent. If you put that curve on here, it almost stands on its end. It looks like a hockey stick. It goes up so sharply 10 percent growth. It doubles in seven years, it is four times bigger in 14 years it is eight times bigger in 21 years.

There is a lot of concern about filling the gap. Because if we do not fill that yellow gap, then something is going to happen to our quality of life and to the world's economy. And I would submit that maybe that is not the goal that we ought to have filling that gap. Because if there is only so much energy out there, the more that you use to fill the gap, the lesser it is going to be in the future. There is an old adage that says that when you are in a hole stop digging. A good corollary to that would be if you are climbing a hill and you know that you are going to fall off a precipice on the other side of the hill, the steeper the hill, the higher the hill, the bigger the drop will be on the other side. And if all we are doing in trying to fill that gap is using up precious energy resources, they will not be available for the future.

The cheapest oil that we use that we buy is the oil that we do not use. In reality, Mr. Chairman, where we are today if you look at this curve, all the oil that the world can produce is required by the world's economies or oil would not be $60 a barrel. It opened at just over $60 a barrel this morning. And so if we are going to have any energy to invest in

alternatives and it will take three things to invest in these alternatives. Money we will not worry about that. You and I worry, Mr. Chairman, but many do not. We will just borrow that from our kids and our grandkids so we do not worry about money. But you cannot borrow time and you cannot borrow energy from our kids and our grandkids. And we are going to have to make big investments of both time and energy to get these alternatives. In order to have energy to invest, we are going to have to have enormous conservation efforts now so that we free up some of the oil because if in fact we are reaching peak oil, when we have reached peak oil, all the oil that is produced is needed by the world's economies, none will be available to invest in the alternatives that we need to invest.

So I would suggest that maybe the goal would be to find a way to have high quality of life without increasing energy use. Because if you look back at that previous slide and see the enormous amounts of energy we have used and this age of oil will end. We will transition to alternatives.



Renewable energy as share of U.S. energy comsumption, 2000
(Source: U.S. Energy Information Administration)

The next slide addresses that transition to the alternatives. And I use a little analogy which I think helps us understand where we are. We are very much like the young couple whose grandparents have died and left them a big inheritance and they now established a lifestyle where 85 percent of the money they spend comes from their grandparent's inheritance and only 15 percent from their income. But they look at their grandparent's inheritance and the amount they are spending and it is going to be gone before they retire. So they are going to clearly have to do one of two things. Either spend less money or make more money. I use the 85/15, some people use 86/14, but 85 percent of the energy we use today comes from fossil fuels. And only 15 percent of the energy comes from the alternatives.

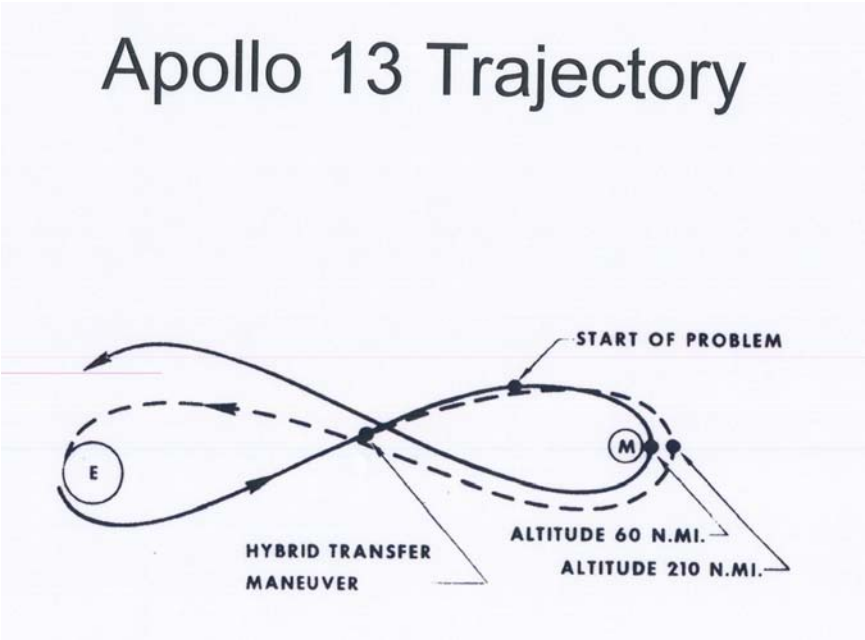
By and by, all of the energy will need to come from the alternatives. Of the 15 percent that is not fossil fuels, a bit more than half of that comes from nuclear. This could and should grow probably. But that will not be the water reactors we have because fissionable uranium is of finite supply in the world. We will have to move to breeder reactors and buy the problems that come with that. And that may be quite preferable, Mr. Chairman, to shivering in the dark, if that is your alternative in the future.

I gladly support on the Science Committee all the money that the people working on fusion can profitably use but I think planning to solve our energy future with fusion is a bit like you or more planning to solve our personal economic problems by winning the lottery. That would be nice but do not count on it. And I think the odds of fusion are about the same of you and me serving our, solving our personal financial problems by winning the lottery.

Now we have exploded out here the 7 percent renewable energy and notice that almost half of that is conventional hydro. We have maxed out in our country. We might go to some micro hydro and get almost as much and we really need to be exploiting that. But we have dammed up all the rivers that we should have dammed and maybe a few that we should not. The next biggest source of alternative energy is wood. Not the West Virginia hillbilly, it is the timber industry and the paper industry wisely burning what would otherwise be a waste product. And then the next biggest one is waste and we really ought to be doing more of that burning waste. You can make a short trip up here into Montgomery County and see waste-burning generation that I would be proud to have next to my church or my home. It looks like an office building, you never see the waste it is trucked in containers it is dumped inside the building. It is really a great technology. It is very profitable to go there and see it.

And now we are down to the things that we will transition to in the future, solar. This is a graph from 2000. We have been growing at 30

percent a year. That doubles in two and a half years. We are four times bigger. It was .07 percent in 2000 it is now .28 percent, big deal. That is a long way from any meaningful contribution. The same thing is true of wind. Just a word of caution about energy from agriculture, the world has to eat. If we will eat the corn and the soybeans that the pig and the chicken and steer would have eaten, maybe we can get more energy from agriculture. And be careful, Mr. Chairman, about taking biomass to produce energy because we are barely able today to maintain the quality of our topsoils with returning much of that biomass that is humus in the soil. Geothermal here and there we need to exploit as much of that as we can.



The last slide shows an interesting analogy and that shows the Apollo, we are very much like the Apollo astronauts. They found themselves, Apollo 13 astronauts they found themselves with a really big problem. They were going to die if they did not do something quickly and do some things right. And so they noted all the assets that they had. They looked at what they could do with them. And they, you know, a failure was not an option. And I think that the kind of commitment that they had, the kind of commitment that we had in World War II and you and I lived through that, every American was involved in World War II. No new cars were made for three years. They rationed gasoline. They rationed tires. They rationed sugar. You brought the grease from your kitchen to a central depository. And I think, Mr. Chairman, we need a program which is kind of the combination of putting a man on the moon, the

urgency of the Manhattan Project and the involvement of everyone of our citizens like in World War II, if we are not going to have a bumpy ride.

Just like to know--and I think that he is probably more pessimistic than he needs to be, if you will do a Google search for Peak Oil and pull up Matt Savinar's article, he may be audacious, Mr. Chairman, but he is not an idiot. And he begins that article by saying dear reader, civilization as we know it is coming to an end soon. I hope not, Mr. Chairman. We need to make sure that Matt Savinar is wrong by galvanizing our people, by challenging our technical people to meet this challenge.

Thank you very much.

[The prepared statement of Hon. Roscoe G. Bartlett follows:]

PREPARED STATEMENT OF HON. ROSCOE G. BARTLETT, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MARYLAND

Chairman Hall, Ranking Member Boucher, Members of the Energy and Air Quality Subcommittee, I appreciate the opportunity for me and my good friend from New Mexico Tom Udall to testify before you today in our capacity as the co-chairmen of the House Peak Oil Caucus. I thank the Committee for scheduling this hearing and inviting distinguished witnesses to discuss House Resolution 507 which expresses "the sense of the House of Representatives that the United States, in collaboration with other international allies, should establish an energy project with the magnitude, creativity, and sense of urgency that was incorporated in the `Man on the Moon' project to address the inevitable challenges of `Peak Oil'."

Shell Oil company geologist M. King Hubbert first identified "Peak Oil" in the 1940's and 1950's. He discovered oil field production follows a bell curve. Oil flows slowly at first, then rapidly increases, reaches a maximum or peak when half of the oil has been extracted, and then production declines rapidly.

Adding the curves from individual wells in the United States, Hubbert projected in 1956 that "Peak Oil" for the United States would occur in 1970. He was right. U.S. oil production peaked and has declined every year since 1971. Despite sharp increases in prices and better technology, US domestic oil production has declined every year since then.

The U.S. has only two percent of world oil reserves. We contribute eight percent of world production. That means we're pumping our reserves four times faster than the rest of the world. We consume 25 percent of world oil production. U.S. natural gas production has also peaked. The United States is now the world's largest importer of both oil and natural gas. From importing one third of the oil we use before the Arab Oil Embargo, the U.S. now imports about two thirds of the oil we use.

After U.S. oil production peaked in 1970, our country started and we are continuing to accelerate down a path of growing energy insecurity. The United States used to be the world's largest oil producer. After the U.S. peaked in 1970, Saudi Arabia became the world's largest single oil producer and the leader of OPEC nations which became the world's dominant oil suppliers.

Just as Hubbert was right about the United States, peak oil has occurred in other countries and global peak oil will happen. Oil production is declining in 33 of the world's 48 largest oil-producing countries. The Associated Press just reported that Texas oil and natural gas production declined five percent in the first nine months of 2005. Global "Peak Oil" has not yet occurred, but will mark the maximum annual world

production of this source of cheap energy. It has utterly transformed America and the world in the past 100 years.

At the start of the age of oil, world population was one billion; now it's seven billion. The population of the United States is almost 300 million and increasing by nearly 30 million people every decade. Nitrogen fertilizer is made from natural gas. In a very real sense, oil feeds the world.

President Bush has committed the Administration to reducing America's energy insecurity. I met with the President at the White House on June 29, 2005 and was impressed by his understanding of the need for our government to act now to prepare for global "Peak Oil". On October 5, 2005, Department of Energy Secretary Samuel Bodman requested the National Petroleum Council to study "Peak Oil" and the oil and natural gas industry's ability to produce enough oil and natural gas at prices that would not cripple the American economy. Our country's leadership is slowly becoming aware of "Peak Oil". However, it is my hope because of hearings like this and the testimonies given by some of our most prominent figures, our country's leadership will start to see the urgency in addressing this issue, and make it the centerpiece of their agenda.

For example, in testimony before the U.S. Senate Committee on Foreign Relations on November 16, former CIA Director James Woolsey discussed "seven reasons why dependence on petroleum and its products for the lion's share of the world's transportation fuel creates special dangers in our time." 1. Transportation infrastructure is dependent upon oil 2. The Middle East will continue to be the low-cost and dominant petroleum producer. 3. Petroleum infrastructure is highly vulnerable to terrorist and other attacks. 4. The possibility is increasing of embargoes or supply disruptions under regimes that could come to power in the Greater Middle East. 5. Oil revenue transfers fund terrorism. 6. Current account deficits for a number of countries create risks ranging from major world economic disruption to deepening poverty that could be reduced by reducing oil imports. 7. Oil used for transportation produce greenhouse gases that increase the risk of climate change.

The planes, ships and trucks of our military run on oil. Tight supplies and high oil prices threaten our national security and the Department of Defense is responding. For instance, in an October 11, 2005 memo on "Assured Fuels," Assistant Secretary of the Navy for Research, Development and Acquisition John J. Young, Jr., endorsed a recommendation by the Naval Research Advisory Committee in its "2005 Summer Study of Future Fuels" to set the goal of the Navy to become independent from reliance on foreign oil by 2020. Secretary Young explained, "In light of the current painful reality of DoD fuel price adjustments, and the risks to our fuel sources posed by natural disasters and terrorist threats, I believe we need to act on this recommendation with a sense of urgency."

For many years, Saudi Arabia maintained enough production flexibility to leverage oil prices at around $20 per barrel. In recent years, the cushion between world supply and demand whittled away. Three years ago in November 2002, the prompt price for immediate delivery of oil was $27 per barrel NYMEX WTI (New York Mercantile Exchange – West Texas Intermediate). The price for contracts on 10-year long term derivatives combining NYMEX and forward swaps market transactions was between $22 and $24 per barrel. Beginning in December 2003, the price for 10-year contracts began a sharp upward trend that has not abated. The change was prompted by an increase in long term contract purchases by the Chinese and the judgment by market participants that Saudi Arabia could no longer maintain sufficient extra capacity to drive the price of oil down.

In November 2005, the prompt price for immediate delivery of oil was $60 per barrel after a spike to $71 per barrel after Hurricane Katrina. The price for 10-year contracts was $59 per barrel. In the past three years, the prompt price increased two times from $27 per barrel to $60 per barrel. The 10-year price increased almost three times from $22 per

barrel to $59 per barrel. The world's largest banks are the primary transactors in the private forward swaps markets on behalf of clients who are among the world's largest and best financed institutions and companies. Those price increases in oil, the emergence of a well-defined forward swaps market in oil and the larger magnitude increase between the prompt and 10-year price represent a dramatic change in world oil markets.

A December 1, 2005 CRS report (prepared at my request) documents and ranks countries that experienced declines in oil production between 2003 and 2004. Despite the increase in oil prices, United Kingdom oil production declined 228 thousand barrels. United States oil production declined 159 thousand barrels. Australia declined 83 thousand barrels. Norway declined 76 thousand barrels. Indonesia declined 57 thousand barrels. Argentina declined 50 thousand barrels. Other countries with production declines included: Egypt, Oman, Syria, Yemen Brazil, Columbia and Italy.

At the same time, demand for oil is increasing. China and India are increasing their oil consumption. China increased consumption 51.3% and is the world's second largest importer of oil, behind the United States. Developing countries around the world are increasing their demand for oil consumption at rapid rates. For example, the average consumption increase, by percentage, from 2003 to 2004 for the countries of Belarus, Kuwait, China, and Singapore was 15.9 percent;

In order to keep energy costs affordable, improve the environment, safeguard economic prosperity, and reduce the trade deficit, the United States must move rapidly to increase the productivity with which it uses fossil fuels, and to accelerate the transition to renewable fuels and a sustainable, clean energy economy. There is no one silver bullet to solve this problem. Only through a combination of conservation, improved efficiency, and a combination of alternate sources of energy for transportation and ultimately renewable sources of energy (i.e. wind, solar, geothermal, harnessing ocean tides) will we be able to meet the energy demands of the future.

How and when we as individuals and government leaders will respond to global "Peak Oil" is what we need to address immediately. I believe global "Peak Oil" presents our country with a challenge as daunting as the one that faced the astronauts and staff of the Apollo 13 program. Contingency planning, training, incredible ingenuity, and collaboration to solve the problem brought the Apollo 13 astronauts back home safe. The U.S. government must lead and inspire Americans' unmatched ingenuity and creativity to end our unacceptable and unsustainable energy vulnerability and to prevent a worldwide economic tsunami from global "Peak Oil". We in the Congress must work with and on behalf of our constituents to debate, develop and start implementing appropriate policy changes and legislation to make Americans more secure, as we did in the 1940's with the Manhattan Project.

The federal government took an active role in funding a crash program, in partnership with the United Kingdom and Canada, to develop the first nuclear weapon in order to defeat Nazi Germany. Now, we again must adopt a crash program, this time in cooperation with our international allies. We must overcome the obstacles we can foresee and those that will emerge. "Peak Oil" will inflict unprecedented pressure upon our citizens and strain the capability of our social, economic, and political institutions. We must survive the challenges of "Peak Oil" only with the tools we have available. We have no choice.

MR. HALL. Well, I thank you and that was just simply great. Your five minutes are up.

MR. BARTLETT. Yes, sir, thank you, sir. You are very charitable.

MR. HALL. Well, it was really super and I look forward to reading that again. I am not going to ask you for a second reading, but I am

going to read it myself when this gentleman over here unbelievably has taken that down and we will all get to see it again. Everybody is going to have an opportunity to see that. It was super. It was great.

Tom, I recognize you, sir, for as much time as you take.

MR. UDALL. Mr. Chairman, I think I already gave mine.

MR. HALL. All right, then you do not have an answer to that?

MR. UDALL. No, no, I am going to wait for the questions here.

MR. HALL. I understood you were to open and close. I noticed you were attorney general here.

MR. UDALL. Well I am glad that he was closing. Thank you, Mr. Chairman.

MR. HALL. I think our chairman is gone, isn't he, Mr. Barton?

All right, ready for questions. You know, my mother always told me it is better to remain silent and be thought a fool then to open your mouth and remove all doubt. I do not hardly know how I am going to question you. As a matter of fact, I do not really have any questions of you two in that we work together and we have access to your knowledge. And I am not sure that any of us do. Do you have questions of these two gentlemen?

MR. GREEN. I do not have question.

MR. HALL. Do you have, John?

MR. SHIMKUS. I just wanted to--I told in my opening statement I mentioned to Roscoe, Roscoe mentioned some of the mid-term type of BTU conversion issues and I guess I think what would be helpful as we move forward, Roscoe, if we would set some short, mid, and long-term goals because I am a real believer in the market. And I believe that as we have seen in this environment that when you have constrained supplies and high demand and the prices do go up, that is a quicker way to get technological response than Government intervention. You see the public move to hybrid vehicles because they are paying a lot for gasoline at the pump. Government incentives, I always am hesitant to believe that the Government moves faster than the market would move.

But so on the BTU conversion thing that I said I was going to mention, 250-year supply of coal assets within this country and that would probably be a mid-term strategy to help ease this future strain as we look for other alternatives in the future. And then I would also like you to address the hydrogen economy and finally we did talk about, you did mention solar right at the end. Obviously, the Israelis are doing great research in solar energy and their ability to turn using solar energy into hydrogen. Can you just mention any of those applications?

MR. BARTLETT. Well thank you.

Let me mention the hydrogen economy first. Hydrogen, of course, is not a source of energy. We will always use more energy producing

hydrogen than we get out of it because we are not going to suspend the first and second laws of thermodynamics. That does not mean hydrogen is not a good idea. Because when you finally burn it, you get only water. You can use it in a fuel cell that has twice the efficiency of a reciprocating engine. But to understand what hydrogen will do for us, please think of it as a battery. It is just a way of carrying energy from one place to another. We use electron batteries now. Hydrogen may, in fact, be a more dense energy storage medium than the electron batteries but it is not a solution to our energy problem, it is simply a way--for instance, using energy from coal, you cannot put a trunk full of coal in your car and go down the road. But you can use coal to produce electricity. The electricity can split water into hydrogen and oxygen. You can then use the hydrogen in a fuel cell to take your car down the road. So you can run, you can use coal to take your car down the road. So I am much appreciating the interest in hydrogen. I am simply saying that is not a solution to our problem--

MR. SHIMKUS. In this debate as we do in the Energy Committee, I mean, the problem I have with energy is a catcher everybody thinks you use. In this debate, people think you are using, we are using crude oil for electricity generation. Energy is a big arena. Most of our electricity generation is not from oil. So the application for oil is probably in the transportation arena. So then if you shift and move to hydrogen fuels, you are mitigating that. If you address renewable fuels, you are mitigating that but you also have the--if you are generating electricity through the nuclear industry, you are also making a possibility to use that for hydrogen production. So that is the exciting things that are going on. A lot of these were addressed in the Energy Bill and we just have to be careful when we talk about this energy debate not--the assumption here is crude oil is everything and crude oil is not everything because electricity generation, only a small portion of our electricity generation is done by crude oil.

MR. BARTLETT. Liquid fuels most of which comes from crude oil, 70 percent of that fuels our transportation. And you mentioned coal we have 250 years of coal. At current use rates increase its use only 2 percent exponential, that 250 years shrinks to 85 years. Then allow, you have to invest some energy in converting the coal to a gas or a liquid. By the way, Hitler ran his whole military on coal oil. When I was a little boy, the lamp that burned in the corner, we did not have any electricity we called it a coal oil lamp. And after a long time, after using electricity, I still call it a coal oil lamp because we went from whale oil to coal oil before we went to kerosene. So we certainly can convert this. Now you are down to 50 years that is all you have got of pretty dirty stuff. Either you are going to pay an environmental penalty or your--

MR. SHIMKUS. Well I would differ. You know it may have been very dirty stuff in World War II. I would say that--

MR. BARTLETT. Well it is still dirty, we just--

MR. SHIMKUS. I would say just as your waste electricity plant is cleaner today, it is cleaner than waste to electricity 40 years ago and I would submit to you that coal or liquid BTU conversion is as clean if not cleaner than any generation we currently have especially the grandfathered coal generating facilities.

MR. BARTLETT. You mentioned oil shales and tar sands. Of the--as I mentioned, the dollar profit ratio is now really good for Canada. The energy profit ratio is less than nothing. So we have to find a way to make the energy profit ratio positive or you will not end up doing that. Shell has had an experiment out in Colorado and they--and I was out at a Peak Oil conference in Denver a couple of weeks ago and the investigator there was very cautious. This is only experimental, we do not know whether it is economically feasible or not. I hope it is. There is an enormous amount of energy there. But the technique they use to get it is not very scaleable. It will take a long time.

And when you talk about the marketplace working, we almost deify the marketplace. I would remind you that even some things God cannot do. God cannot make a square circle. And when your--the marketplace will work if there are infinite resources. There are not infinite resources here. And so you have to qualify what the marketplace can do in terms of that. Certainly it will work. It is working. I think oil is $60 a barrel now rather than $80 a barrel because the increased price of energy has reduced the demand for energy. So the marketplace does work. But as you will hear in later testimony from SAIC, there is--none of the alternatives have the potential for being ramped up quickly enough to make up the slack, to fill the gap that we talked about. That is the reality. We should have started 20 years ago if we wanted to make sure we were not going to have any dislocations in this transfer.

MR. HALL. The gentleman yields back his time.

Ms. Solis, we would recognize you for your questioning.

MR. SOLIS. Thank you, Mr. Chairman.

And I apologize for coming in late. I do not have any questions except to say that I think this is a very interesting topic and we do need to look at alternative resources of energy so I strongly support what you are looking at and hope that this resolution will move on.

Thank you.

MR. HALL. Ms. Wilson?

MR. WILSON. No questions.

MR. HALL. Mr. Sullivan?

All right, if you would like to join us, we invite you to. Thank you very, very much for all the time and work you put into it and for the presentation.

All right, we are ready for the second panel now if you all are here. All right, we welcome Dr. Aleklett. We thank you Professor for coming all the way from Sweden to make this presentation. I hope you had other items here in the States and in this area but you made a long journey and we look forward to hearing from you. We have Dr. Hirsch, the Senior Energy Program Advisor. He came all the way from Virginia and that was good of you to do that; Robert Esser, Senior Consultant and Director of Cambridge Energy Research Associates of New York; and Murray Smith who is a Minister, Counselor of the Canadian Embassy is on a conference call right now with the Canadian Premier and he may be back in time but he was here and perhaps he will be back in time for us to hear him.

We will start off with Dr. Aleklett, and recognize you for five minutes, or as close thereto as you can keep your testimony. Do not let Mr. Bartlett be an example for you. We had to make special concessions to him because he is our leader up here.

STATEMENTS OF KJELL ALEKLETT, PH.D., PROFESSOR, DEPARTMENT OF RADIATION SCIENCES, UPPSALA UNIVERSITY; ROBERT L. HIRSCH, SENIOR ENERGY PROGRAM ADVISOR, SAIC; AND ROBERT ESSER, SENIOR CONSULTANT AND DIRECTOR, GLOBAL OIL AND GAS RESOURCES, CAMBRIDGE ENERGY RESOURCE ASSOCIATES

MR. ALEKLETT. Thank you very much, Mr. Chairman and members of the committee for inviting me from Sweden for this historic hearing on understanding the Peak Oil theory.

By choosing the wording Peak Oil Theory, some persons might think that this is just a theory and it is not reality. I must say sorry, ladies and gentlemen, Peak Oil is reality. And my grandchildren, Olof and Olivia, born earlier this year, they will face Peak Oil. And it looks like they are going to face it soon.

As a summary of my written testimony, I would like to highlight the following points. Peak Oil will come as oil is a limited resource. Fifty years ago, we were using 4 million barrels per year and the discovery rate at that time was 30 billion barrels per year. Today, we are using 30 billion barrels per year and the discovery rate in new oil fields are approaching 4 billion barrels per year. And the problem is that we can only empty the reserves that we have in a limited speed. Depending on

demand, Peak Oil will happen within the near future. Currently, the Year 2010 is the most likely year for Peak Oil. Another problem is that most countries, if you look around the world, are planning to increase their import of oil. Very few countries are planning to decrease their import of oil. And the question is then how should we make the delivery, how should we be able to produce more oil to export. And if you look at the 20 largest countries for export, you have as number two on the list, Soviet Union or excuse me, Russia. Russia will not increase their export because they need more oil within Russia. Number three on the list is Norway, and the production in Norway is declining now with 10 percent per year. And I could go down the list. In principle, there are only one, two, three, four countries that increase their production on the export list.

Studies of the correlation between oil consumption and the growth of GDP in individual countries as for instance Sweden or China, as well as for the world, shows that since the Second World War, there has not been an increase in GDP without an increase or use of oil. Many countries in the world are very poor. It may be necessary to double the global GDP to achieve any kind of decent lives for people in these countries. The examples of Sweden and China suggest that if past economic development patterns are followed, doubling GDP will require doubling global oil production. And the question is can this ever be done?

The United States of America with 5 percent of the world's population should not in the future continue to consume 25 percent of the global oil production if this means that other nations will not have enough of essential fuels. There should be a human right for energy as there is a human right for water.

The enormous resources of oil sands in Canada are often mentioned as a lifesaver for the world. Our group in Uppsala has made studies that show that even the crash program for production of oil from Canadian oil sands will yield only a limited amount of oil. By 2018, it might be possible we could use 3.5 billion barrels per day. If that should rise to 6 million in 2040, they need to open up a couple of nuclear power plants to get heat to get the oil out of the ground.

The role of the Swedish Academy of Science is an independent non-Government organization with expertise in most of the sciences. The academy has a made a statement about oil and the following is a note from this statement. To avoid acute, economic, social, and environmental problems worldwide, we need a global approach with the widest possible international cooperation. Activities in this direction have started and they should be strongly encouraged and intensified.

The technically advanced countries like the United States have a particular responsibility. If you or one of the members of the committee have grandchildren, or maybe hope to have grandchildren, they will also face Peak Oil. What you decide to do will affect the future for our grandchildren. I hope that you are not the kind of politicians we used to see that can only promise that they can do better in the future and maybe promise to take care of crisis when it happens. As Peak Oil is here in the near future, we need action now and I hope the committee has a lot of questions and I hope that I can give answers that will straightened out those question marks.

Thank you very much for inviting me.

[The prepared statement of Kjell Aleklett, Ph.D., follows:]

PREPARED STATEMENT OF KJELL ALEKLETT, PH.D., PROFESSOR, UPPSALA UNIVERSITY, SWEDEN

Summary:

- Peak Oil will come, as oil is a limited resource. As we use 30 billion barrels per year and new discoveries are much less than this, we are now consuming from our reserves. Depending on demand Peak Oil will happen within the near future. Currently year 2010 is the most likely year for Peak Oil.
- Studies of the correlation between oil consumption and the growth of GDP in individual countries as well as for the world shows that since 1900 there not has been an increase in GDP without an increase in the use of oil.
- USA with 5 percent of the world's population should not in future continue to consume 25 percent of the global oil production if it means depriving other nations of essential fuels.
- Even a crash program for production of oil from Canadian oil sands will yield only a limited amount of oil.

Mr. Chairman, ladies and gentlemen on the committee:

I thank the Committee for this opportunity to discuss Peak Oil and the work of Uppsala Hydrocarbon Depletion Study Group, Uppsala University, Sweden. We are also members in the network of ASPO, the Association for the Study of Peak Oil and Gas, and I'm since 2003 president of ASPO. Members of ASPO, including the ASPO-USA affiliata, have an interest in determining the date and impact of the peak and decline of the world's production of oil and gas, due to resource constraints (www.peakoil.net).

The mission is to:

1. Define and evaluate the world's endowment of oil and gas.
2. Model depletion, taking due account of demand, economics, technology and politics.
3. Raise awareness of the serious consequences for Mankind.

I like to summarize the global situation for Peak Oil the following way: When I was born in 1945, none of the four small farms in my little Swedish village used oil for anything. Ten years later, the oil age had arrived: we had replaced coal with oil for heating, my father had bought a motorcycle, and tractors were seen in the fields. From 1945 to 1970, Sweden increased its use of energy by a factor of five, or nearly 7 percent per year for 25 years. This journey into the oil age transformed Sweden from a rather

poor country into the third wealthiest country (per capita) in the world. Ninety percent of the energy increase came from oil. Cheap oil made Sweden rich.

Now consider China, a developing country with 21 percent of the global population. It consumes 8 percent of the global oil supply, and thinks it is fair to claim 21 percent of daily global consumption, or 17.6 million barrels per day (mbpd). During the last five years the average annual GDP growth in China has been 8.2 percent and the average increase in oil consumption 8.4 percent per year. We can now see the same correlation between increase in GDP and use of oil in China as in Sweden 50 years ago. If China's economy grows 8 percent per year over the coming five years, we can expect that it will need an increase in the consumption of oil of 3 million barrels per day by 2010. According to Professor Pang Xiongqi at the China University of Petroleum in Beijing, China's production will plateau in 2009 and then start to decline. This means that the total increase in consumption must be imported. As China is already importing 3 million barrels per day, it will have to increase imports 100 percent during the next five years. Where will it come from?

Since 2001, when ASPO was founded, we have tried to tell the world that there will soon be a problem supplying the world with crude oil while demand continues to rise. The estimated peak-production year at the first depletion workshop in Uppsala in 2002 was 2010. Two years later at our Berlin meeting it had moved to 2008, and now it looks like we are back to 2010, because production from deepwater oil fields will yield more than we expected. The exact year for peak oil depends very much on future demand and we will not know when we have peaked until we have crossed the threshold. It will certainly happen before 2020.

Unfortunately, few have heeded our alerts, even though the signs have been so obvious that a blind hen could see them. Fifty years ago the world was consuming 4 billion barrels of oil per year and the average discovery rate (the rate of finding undiscovered oil fields) was around 30 billion barrels per year. Today we consume 30 billion barrels per year and the discovery rate is dropping toward 4 billion barrels per year (see figure 1). This is significant; Chevron is even running an ad saying, "The world consumes two barrels of oil for every barrel discovered." (By discovery, I mean only new oil fields. Some analysts include reserve growth—newly accessible oil in old fields—as new discoveries, but we are using the same approach as in World Energy Outlook 2004, IEA, International Energy Agency)

If we extrapolate the downward discovery slope from the last 30 years in figure 1, we can estimate that about 135 billion "new" barrels of oil will be found over the next 30 years. The latest large oil field system to be found was the North Sea (in 1969), which contains about 60 billion barrels. In 1999 the North Sea field production peaked at 6 mbpd. Our extrapolation suggests that over the next 30 years we will discover new oil fields equal to twice the size of the North Sea—a very pessimistic prediction, according to our opponents. But I think the oil industry would be ecstatic to find two new North-Sea-size oil provinces.

The World Energy Outlook 2005 base-case scenario projects that by 2030 global oil demand will be 115 million barrels per day, which will require increasing production by 31 million barrels per day over the next 25 years, of which 25 mbpd is predicted to come from fields that have yet to be discovered. That is, we'll have to find four petroleum systems of the size of the North Sea. Is this reality?

Every oilfield reaches a point of maximum production. When production falls advanced technologies can reduce but not eliminate the decline. The oil industry and the IEA accept the fact that the total production from existing oil fields is declining. ExxonMobil informed shareholders that the average production decline rate for the global oil fields are between 4 and 6 percent per year (The Lamp, 2003, Vol85, No1). Current global production is 84 million barrels per day, so next year at this time current fields may produce a total of roughly 80 million barrels per day. Given the expected increase in

global GDP, one year from now total oil demand will be 85.5 mbpd—so new capacity might have to make up for 1.5 mbpd plus 4 mbpd, or 5.5 mbpd. Two years from now the needed new production will be 11 mbpd and in 2010 at least 25 mbpd. Can the industry deliver this amount? If we extend the decline in existing fields through 2030, and accept the 2004 scenario by the Energy Information Administration (global demand of 122 mbpd), then "we need new production that is of the order of 10 new Saudi Arabias." Some might call this a doomsday scenario, but if so I'm not the doomsayer—it's Sadad Al Husseini, until recently vice-director of Saudi Aramco, the largest oil company in the world.

Excluding deepwater oilfields, output from 54 of the 65 largest oil-producing countries in the world is in decline. Indonesia, a member of the Organization of Petroleum Exporting Countries (OPEC), not only can't produce enough oil to meet its production quota, it can't even produce enough for domestic consumption. Indonesia is now an oil importing country. Within six years, five more countries will peak. Only a few countries—Saudi Arabia, Iraq, Kuwait, United Arab Emirates, Kazakhstan, and Bolivia—have the potential to produce more oil than before. By 2010, production from these countries and from deepwater fields will have to offset the decline in 59 countries and the increased demand from the rest of the world.

Can they do it? Let's look at Saudi Arabia, which in the early 1980s produced 9.6 million barrels per day. According to the IEA and the EIA Saudi Arabia must produce 22 mbpd by 2030. But Sadad Al Husseini claims that "the American government's forecasts for future oil supplies are a dangerous over-estimate." The Saudi Ghawar oil field, the largest in the world, may be in decline (see for example the book “Twilight in the dessert” by Mathew Simmons). Saudi Aramco says that production can be increased to 12.5 mbpd in 2015. They plan a new pipeline with a capacity of 2.5 mbpd, so it looks like they are willing to increase production to 12.5 mbpd, but so far there are no signs of reaching 22 mbpd.

Now consider Iraq, which in 1979 produced 3.4 mbpd. Iraq officially claims reserves of 112 billion barrels of crude oil, but ASPO (and other analysts) think that one-third of the reported reserves are fictitious "political barrels." At a recent meeting in London, I was told (privately, by a person who is in a position to know) that Iraqi reserves available today for production total 46 billion barrels. If this is the case, it will be hard for Iraq to reach its former peak production level in a short time. And so on. It's time to ask, can the Middle East ever again produce at the peak rates of the 1970s?

Many countries in the world are very poor. It may be necessary to double global GDP to achieve any kind of decent life for people in these countries. The examples of Sweden and China suggest that, if past economic development patterns are followed, doubling GDP will require doubling global oil production. Can this even be done?

The United States, the wealthiest country in the world, has 5 percent of the global population and uses 25 percent of the oil. It is time to discuss what the United States should do to cut consumption—and rapidly. In February 2005 a report for the U.S. Department of Energy, DoE, (Peaking of World Oil Production: Impacts, Mitigation, & Risk Management) argued that "world oil peaking represents a problem like none other. The political, economic, and social stakes are enormous. Prudent risk management demands urgent attention and early action." Any serious program launched today will take 20 years to complete.

What about oil sands? The enormous reserves of oil sands in Canada are often mentioned as a lifesaver for the world. The report to DoE in February inspired us to undertake a “Crash Program Scenario Study for the Canadian Oil Sand Industry” (B. Söderbergh, F. Robelius, and K. Aleklett, to be published). In the study we found that Canada must very soon decide if its natural gas should be exported to USA or instead used for the oil sands industry. In a short-term crash program the maximum production from oil sands will be 3.6 million barrels per day in 2018. This production cannot offset

even the combined decline of just the Canadian and North Sea provinces (see Fig.2). A long-term crash program would give 6 million barrels by 2040, but then new nuclear power plants would be needed to generate steam for the in-situ production.

In view of the importance of the world's future energy supply, The Royal Swedish Academy of Sciences (the Academy that awards the Nobel Prizes in physics, chemistry, and The Bank of Sweden Prize in Economic Sciences in Memory of Alfred Nobel) has recently established an Energy Committee. The Academy is an independent non-governmental organization, with expertise in most of the sciences as well as economic, social, and humanistic fields. The Energy Committee has selected a number of subjects to be studied in some depth and one of these deals with oil and related carbon-based fuels. The Academy organized hearings and a seminar before subsequently (on October 14, 2005) issuing a statement about oil (the full statement can be found at the end of this text). I'll note just one excerpt from the general remarks: "It is very likely that the world is now entering a challenging period for energy supply, due to the limited resources and production problems now facing conventional (easily accessible) oil."

From figure 1 we can conclude that the peak of global discovery of oil was around 1960. In figure 3 we have a well-defined discovery peak for US Lower 48. This peak defines how much can be produced and Peak Oil for the region was 35 years later in 1971. Based on the assumption that we only can consume the oil we have already found and expect to find, we have predicted oil production in the future for the world till 2050 (figure 4). Deep water is the latest oil-production frontier. During the coming years a number of large fields will come into production, and we believe that the peak production from these fields will define the upper time limit for peak oil. Based on the data available today, we can expect global Peak Oil in 2010, with a few years uncertainty.

Animals that face food shortages have a hard time adjusting and usually their populations decline. Some believe that we as human beings will face a similar situation. I can't accept that. As human beings we can think and come up with ideas, and I believe we can find solutions. The road will be bumpy and many people will be hurt, but when we arrive at the end of this road, it must be as a sustainable society. It will not be possible to travel this road without using part of the existing stocks of fossil fuels and, for industrial countries, nuclear energy as well, but we can do it in a manner that will have minimal impact on the planet. The problem is that we should have started at least 10 years ago. We must act now, as otherwise the bumps and holes in the road might be devastating.

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Association for the Study of Peak Oil and Gas: www.peakoil.net
Association for the Study of Peak Oil and Gas - USA: www.aspo-usa.com

Figures:

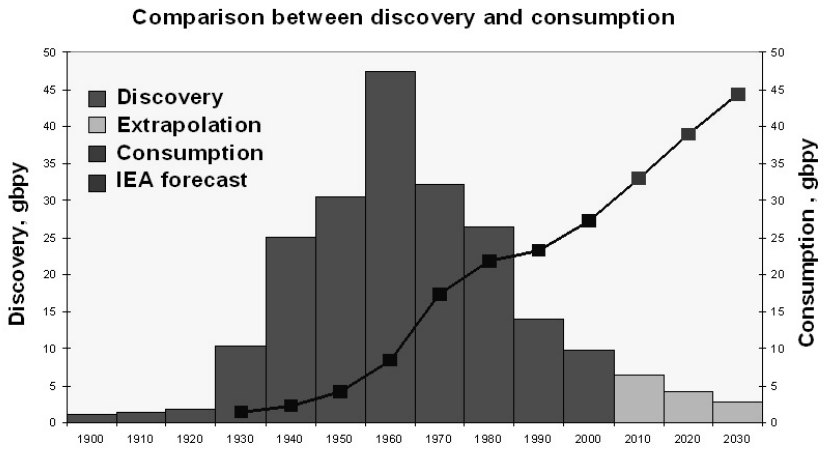

Figure 1: Discovery of conventional oil and extrapolation of future discoveries and consumption of conventional oil and predicted consumption according to IEA. The number for year 2000 is the average number for the years 1995 to 2004, etc. (K. Aleklett, www.peakoil.net)

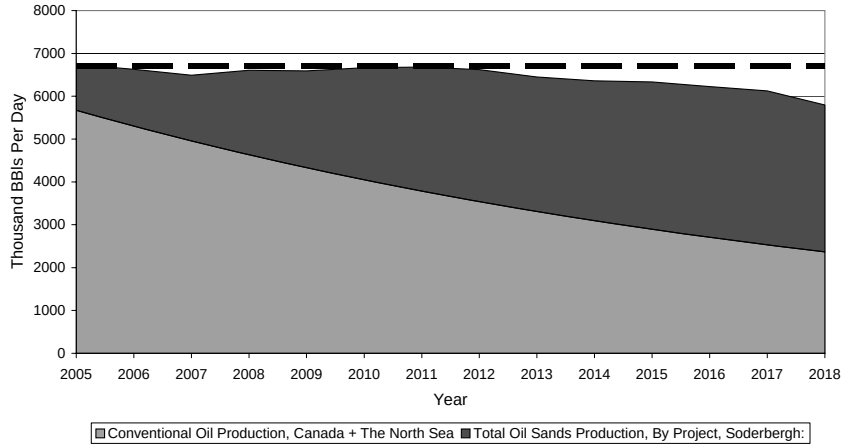

Fig 2. Canadian Conventional + The North Sea + Canadian Oil Sands Crash Program Crude Oil Production 2005 – 2018 (B. Söderbergh, F. Robelius, and K. Aleklett, to be published)

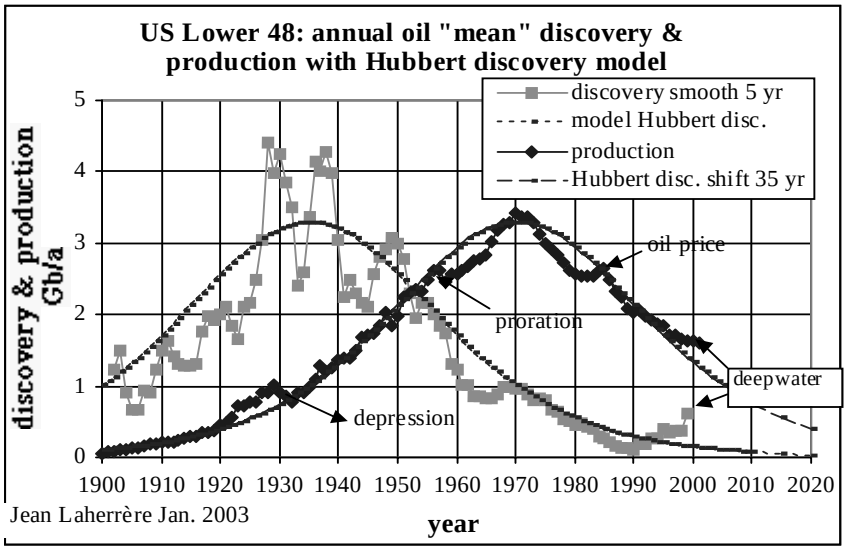

Figure 3: Annual discovery and production of oil in US lower 48 states. (Jean Laherrère, January 2003.)

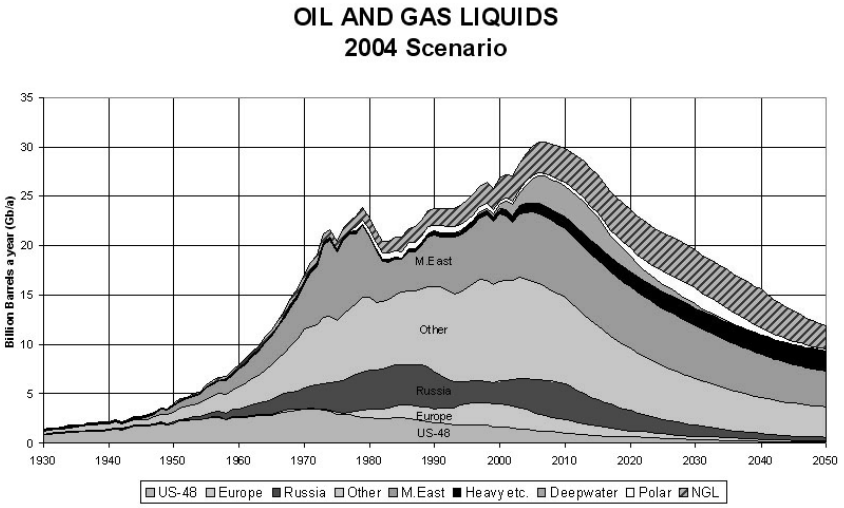

Figure 4: Oil and gas liquids scenario (updated from K. Aleklett and C.J. Campbell, Minerals & Energy, 2003; 18:5-20)

Statements on Oil

by the Energy Committee at
the Royal Swedish Academy of Sciences.

Introduction

The Royal Swedish Academy of Sciences is an independent non-governmental organization, with expertise in most of the sciences as well as economical, social and humanistic fields. The Academy has recently established a committee to consider today's important energy issues that need our full, unbiased attention. The Energy Committee has a national as well as a global perspective and will summarize scientific knowledge on the supply and use of energy as well as the predicted impacts on society over the coming 50 years. Sustainability and environmental considerations are essential for any future energy system. Readily available, inexpensive and environment-friendly energy provides the foundation for economic growth and prosperity.

The Energy Committee has selected a number of subjects to be studied in some depth. One of these deals with oil and related carbon-based fuels. Therefore, the Committee, organized, together with the Committee of Energy and Environment of the Royal Academy of Engineering Sciences, a seminar with the title "Running out of oil – scientific perspectives on fossil fuels" held at the Academy on 26 May 2005. Prior to the Seminar, the Energy Committee conducted a hearing with the seminar participants. More information about this seminar can be found on the Academy's web page www.kva.se. The Committee also arranged a hearing with speakers in an Uppsala seminar on "Global oil reserves" on 23 May 23 2005 together with the Graduate School of Instrumentation and Measurements (AIM). Members of the Committee participated in the Uppsala seminar. Some essential points brought up at the hearings and seminars are highlighted below. It should be pointed out that the perspective given here is not purely scientific, since there are important social, political and technical factors that need consideration.

General remarks

It is very likely that the world is now entering a challenging period for energy supply, due to the limited resources and production problems now facing conventional (easily accessible) oil. Nearly 40 % of the world's energy is provided by oil, and over 50% of the latter is used in the transport sector. An increasing demand for oil from emerging economies, such as China and India, is likely to further accentuate the need for new solutions. In addition, it is important that the poorer countries have access to oil at reasonable prices to meet their development goals. This places an additional burden on responsible, matured economies. Compared to many developing countries, the same percentage increase in the crude oil price will be less problematic for Sweden and other European countries because of our tax system (the crude oil's share, c. 25%, in the gasoline price is quite small, compared to the taxes). The poor countries will suffer most from an increased price.

China and India and several nations in South-East Asia and Latin America are now experiencing rapid economic development. Continued high oil prices will jeopardize their chances of economic growth. Many countries, for example in Africa, may not even be able to develop economically in the absence of cheap oil. With China and India emerging as engines of the global economy, the sharp increase in the oil prices which we are witnessing today could lead to a serious international economic recession, similar to

those that followed the oil price increases in 1973-74 and 1981. The European economies may be severely affected.

There is at present an extreme dependence on supply from the Middle East holding more than 60 % of the global oil reserves. A key country is Saudi Arabia, which is supposed to hold about 20% of the global reserves of conventional oil and much of the world's spare capacity. Some analysts maintain that there are inherent technical problems in the Saudi oilfields, but this is not an uncontested viewpoint. It is uncertain how much the oil production in the Middle East can be increased in the next few years and to what extent it would be in the interest of these countries to greatly increase production. It is clear that, even in these countries, conventional oil is a limited resource that they are almost totally dependent on. It is, however, also clear that the countries of the Middle East are undergoing massive internal and regional changes which may have negative consequences for the global oil supply system. Mitigation measures must be initiated in the next few years in order to secure a continued adequate supply of liquid fuels, especially for the transport sector. Over the longer term, completely new solutions are required. Therefore, increased R&D (Research and Development) in the energy sector is urgently needed.

Key points

1. Shortage of oil

The global demand for oil is presently growing by nearly 2 % per year and the current consumption is 84 million barrels per day (1 barrel=159 liters) or 30 billion barrels per year. Finding additional supplies to increase the production rate is becoming problematical, since most major oilfields are well matured. Already 54 of the 65 most important oil-producing countries have declining production and the rate of discoveries of new reserves is less than a third of the present rate of consumption.

2. Reserves of conventional oil

In the last 10-15 years, two-thirds of the increases in reserves of conventional oil have been based on increased estimates of recovery from existing fields and only one-third on discovery of new fields. In this way, a balance has been achieved between growth in reserves and production. This can't continue. 50% of the present oil production comes from giant fields and very few such fields have been found in recent years. Oil geologists have a wide range of opinions on how much conventional oil there is yet to be discovered, but new reservoirs are expected to be mainly found in the deeper water, outer margins of the continental shelves, and in the physically hostile and sensitive environments of the Arctic, where the production costs will be much higher and lead times much longer than they are today. A conservative estimate of discovered oil reserves and undiscovered recoverable oil resources is about 1200 billion barrels, according to the US Geological Survey; this includes 300 billion barrels in the world's, as yet unexplored, sedimentary basins.

3. Middle East's key role

Only in the Middle East and possibly the countries of the former Soviet Union is there a potential to significantly increase production rates to compensate for decreasing rates in other countries. Saudi Arabia is a key country in this context, providing 9.5 million barrels per day (11% of the current global production rate). Their proven reserves are 130 billion barrels and their reserve base is said to include an additional 130 billion barrels. Iraq also has considerable untapped oil reserves.

4. Unconventional oil resources

In addition to conventional oil, there are very large hydrocarbon resources, so-called unconventional oil, including gas (c. 1000 billion barrels of oil equivalent, much of which could be converted to liquid fuels), heavy oil and tar sands (c. 800 billion barrels) and oil shales (c.2 700 billion barrels); coal, from which liquid fuels can be produced and methane hydrates provide a vast additional potential. During a transition period, gas often available adjacent to the oil fields, will help to bridge future deficits of conventional oil. With the exception of gas, all unconventional oil is expensive to produce (c. $ 20-40/barrel) and exploitation involves significant environmental problems. At $ 40 oil, which is now commonly accepted as the long term equilibrium price, the cost of developing unconventional oil is less problematic. (see pt. 7 below). At present, 1 million barrels of oil per day comes from Canadian tar sand and 0.6 million barrels from Venezuelan heavy oil. The Canadian government estimates that by 2025 the daily production rate will have increased to 3 million barrels per day. Thus, the problem with these unconventional oils is not so much price, but lead times and non-price related aspects, such as the effects on the environment and availability of water and natural gas for the production process.

5. Immediate action on supplies

Forceful measures to improve the search for and recovery of conventional oil as well as improving the production rate of unconventional oil are required to avoid price spikes, leading to instability of the world economy in the next few decades. Improved recovery of oil in existing fields can be expected. The estimated reserves of conventional oil are, however, located primarily in unexplored sedimentary basins, in environments difficult to access. A substantial part has yet to be found! Sizeable contributions from unconventional oil need time (some decades) to become really effective. It is necessary to have public funding for long term petroleum-related research, since this must not be an exclusive task for the oil companies.

6. Liquid fuels and a new transport system

Oil supply is a severe liquid fuels problem and less of a general energy supply problem; 57 % of the world's oil is consumed in the transport sector. Unless government's ration oil, there will never be a shortage of oil; just increasing prices. Major programs need, therefore, to be implemented to develop alternatives to oil in the transport sector. Until these measures have been introduced, (which may take one to two decades) demand for oil for the needs of a globally expanding transport sector will continue to rise; other users of oil will suffer, including those concerned with power generation.

7. Economic considerations

At present the high oil prices are due to the limitations of worldwide production, refining and transportation capacities. Furthermore, the price is influenced by the threat of terrorist attacks on the world's oil supply, transport system and infrastructure. In the long run, the price of crude oil will be determined by the price of substitutes. Some estimates indicate that oil may be produced from tar sand at a price of 20-25 USD a barrel, compared to the present cost of about USD 5 for Saudi Arabian oil. Liquid fuels from coal could be produced for many decades; cost estimates vary greatly and generally exceed USD 30. Factors that are hard to estimate are environmental requirements, taxation levels and profit margins. However, we can anticipate continued high oil prices, as long as the pressure from the expanding Asian economics is maintained.

8. Environmental concerns

Unconventional oil will significantly extend the length of the hydrocarbon era, assuming that the negative impacts on the environment can be avoided. Constraints similar to those imposed on other fossil fuels (for example emission controls and CO2 sequestration) will be necessary and provide major challenges for industry. The impact on the environment, in general, and on the atmosphere and climate in particular, produced by combustion of fossil fuels, is not considered here. However, it is worth noting that such considerations provide further support for the conclusions presented below.

9. Increased R&D and international efforts

To avoid acute economical, social and environmental problems worldwide, we need a global approach, with the widest possible international cooperation. Activities in this direction have started and they should be strongly encouraged and intensified; the technically advanced countries have a particular responsibility. Considerably increased resources for R & D on alternative non-fossil energy sources, as well as on efficient and sustainable use of energy, particularly electricity, are necessary. In order to develop a sustainable energy system beyond the fossil fuel era, we need a full system analysis of the energy sector based on realistic time scales. The Energy Committee intends, in the next couple of years, to study other sources of energy and evaluate their relative merits and impact on environment and climate.

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MR. HALL. Thank you, Dr. Aleklett, thank you very much.
Dr. Hirsch, I recognize you, sir.

MR. HIRSCH. Thank you, sir.

Mr. Chairman, distinguished members, and staff, peaking of world oil production represents an enormous risk to the United States and the world. Peak Oil is not a theory. Maximum conventional oil production is coming, but we cannot predict when because no one has the verified data needed for a credible forecast. Nobody on this planet does. Peaking could be soon. Our studies through the Department of Energy indicate that soon is within 20 years.

The economic future of the United States is inextricably linked to Saudi Arabia because they are the lynchpin of future world oil production. No one outside of Saudi Arabia knows how much oil they have in the ground because that is a closely held state secret. Also, no one outside of Saudi Arabia knows how much and how fast the Saudis will be willing to develop what they have. Like it or not, Saudi Arabia is not required to satisfy world needs and conserving their oil is in their national interest. Think risk.

The literature is awash in failed forecasts of oil peaking. We talked about the boy and wolf a few minutes ago. It has happened a lot of times. Since oil and gas have much in common geologically, it is instructive to review recent forecasts of North America natural gas production to gain some insight into how good those forecasters and forecasts have been. For example, in 1999, EIA and the National Petroleum Council were both optimistic about abundant natural gas supplies in North America for the foreseeable future. That was just a few years ago. Today we have a very severe problem with natural gas supply in this country and that is only a few short years ago. Today, EIA is forecasting adequate world's oil supplies for decades into the future. The question is, are they going to get it right this time? The National Petroleum Council has been asked by Secretary Bodman to assess Peak Oil. Are they going to get it right this time? Think risk.

Until recently OPEC assured the world that oil supply would continue to be plentiful, but that situation is now changing. In fact, a number of people in OPEC are warning that oil supply will be not be adequate to satisfy world needs just 10 to 15 years into the future. A retired Saudi oil executive predicts that the world is headed for an oil shortage. He contends that a whole new Saudi Arabia will have to be found and developed every couple of years to satisfy demand forecasts. He is deeply concerned about what he calls the over-optimism of EIA and IEA. So from the world's breadbasket of oil, the bottom line message is moving from confident assurance to warnings of approaching shortage. Think risk.

A recent analysis for the Department of Energy focused on what might be done to mitigate the peaking world oil production. It became

abundantly clear early in our study that effect of mitigation would be dependent on the large scale implementation of mega projects and mega changes that the maximum rate conceivable and possible. We performed a transparent scenario analysis based on crash program mitigation worldwide which is the fastest that is humanly possible. The timing was left open because we do not know when peaking is going to occur. The results were startling. If we wait until peaking occurs, the world will have a problem with adequate liquid fuels for more than two decades. If we start ten years before peaking occurs, that will allay the problem somewhat but in ten years after that, a problem will arise. And finally, if we initiate a crash program 20 years before peaking occurs, we have the possibility, a possibility of avoiding the problem.

Oil peaking represents a liquid fuels problem not an energy crisis in the sense that that term has been used. Motor vehicles, aircrafts, trucks, and ships have no ready alternative to liquid fuels, certainly not the large existing capital stock. And that capital stock has lifetimes measured in decades. Solar, wind, and nuclear power produce electricity not liquid fuels; their widespread use in transportation is at least 30 to 50 years away.

If we get oil peaking wrong, how bad might the economic damage be? Unfortunately, there is a paucity of analysis in this area which is tough analysis to do. One study called oil shock wave, which I believe was mentioned earlier, was performed by a group of distinguished former high level Government officials not too long ago. They concluded at a sustained 4 percent global shortfall would result in oil at $160 a barrel which would push the United States into recession losing millions of jobs. Note that oil shock wave focused on a multi-year drop in oil supply of 4 percent total but experts in this business will tell you that 4 to 8 percent per year is entirely possible and is happening in many parts of the world. Think risk.

Chinese officials have forecast the peaking world oil production around 2012. As this committee knows, China has been making huge investments to secure oil for its own country doing this around the world and paying premium prices. They tried to buy Unocal and that did not work. They offered a premium in that particular case.

The world has never confronted a problem like Peak Oil. Risk minimization mandates the massive implementation of mitigation well before the onset of the problem. Since we do not know when peaking is going to occur, that makes a tough problem for you folks as decision makers because if you are going to start 20 years ahead of something that is indeterminate, you have a tough time making the arguments. Mustering support is going to be difficult. We would all like to believe

that the optimists are right about peak oil, but the risks, again the risks of them being wrong, are beyond anything that we have experienced.

Think risk and thank you.

[The prepared statement of Robert L. Hirsch follows:]

PREPARED STATEMENT OF DR. ROBERT L. HIRSCH, SENIOR ENERGY PROGRAM ADVISOR, SAIC

SUMMARY

The era of plentiful, low-cost petroleum is approaching an end. A recent analysis for the DOE focused on what might be done to mitigate the peaking of world oil production. It became abundantly clear that effective mitigation will be dependent on the implementation of mega-projects and mega-changes at the maximum possible rate. A scenario analysis was performed, based on crash program implementation worldwide – the fastest humanly possible. The timing of oil peaking was left open because of the considerable differences of opinion among experts. The results were startling: Unless a mitigation crash program is started 20 years before peaking occurs, the economic consequences will be dire.

Oil peaking represents a liquid fuels problem, because motor vehicles, aircraft, trucks, and ships have no ready alternative to liquid fuels, certainly not for the existing capital stock, which has lifetimes measured on a decade scale.

The world has never confronted a problem like peak oil. Since it is uncertain when peaking will occur, the challenge for decision-makers is vexing. Mustering support for an approaching, invisible disaster is much more difficult than for one that is obvious. We would like to believe that the optimists are right about peak oil being a distant problem, but the risks of error are beyond imagination.

INTRODUCTION

The era of plentiful, low-cost petroleum is approaching an end. The good news is that commercially viable mitigation options are ready for implementation. The bad news is that unless mitigation is orchestrated on a timely basis, the economic damage to the world economy will be dire and long lasting.

Oil is the lifeblood of modern civilization. It fuels most transportation worldwide and is a feedstock for pharmaceuticals, agriculture, plastics and a myriad of other products used in everyday life. The earth has been generous in yielding copious quantities of oil to fuel world economic growth for over a century, but that period of plenty is changing.

In the following, we describe the nature of the peaking problem, options for mitigation, and required timing. The exact date of peaking is not known; some think it will be soon, others think a decade or more. However, the date is almost irrelevant because mitigation will take much longer than a decade to impact, because of the enormous scale of world oil consumption.

BACKGROUND

Oil was formed by geological processes millions of years ago and is typically found in underground reservoirs of dramatically different sizes, at varying depths, and with widely varying characteristics. The largest oil fields are called “super giants,” many of which were discovered in the Middle East. Because of their size and other characteristics, super giant oil fields are generally the easiest to find, the most economic to develop, and the longest-lived. The world’s last super giant oil fields were discovered in the 1960s. Since then, smaller fields of varying sizes have been found in what are called “oil prone” locations worldwide -- oil is not found everywhere.

The concept of the peaking of world oil production follows from the fact that the output of an oil individual field rises after discovery, reaches a peak, and then declines. Oil fields have lifetimes typically measured in decades, and peak production often occurs roughly a decade or so after discovery under normal circumstances. It is important to recognize that oil production peaking is not "running out." Peaking is the maximum oil production rate, which typically occurs after roughly half of the recoverable oil in an oil field has been produced. What is likely to happen on a world scale will be similar to what happens with individual oil fields, because world production is by definition the sum total of production from all of the world's oil fields.

Oil is usually found thousands of feet below the surface. Oil fields do not typically have an obvious surface signature, so oil is very difficult to find. Advanced technology has greatly improved the discovery process and reduced exploration failures. Nevertheless, world oil discoveries have been steadily declining for decades.

OIL RESERVES

"Reserves" is an estimate of the amount of oil in an oil field that can be extracted at an assumed cost. Thus, a higher oil price outlook often means that more oil can be produced. However, geological realities place an upper limit on price-dependent reserves growth.

Specialists who estimate reserves use an array of technical methodologies and a great deal of judgment. Thus, different estimators might calculate different reserves from the same data. Sometimes self-interest influences reserve estimates, e.g., an oil field owner may provide a high estimate in order to attract outside investment, influence customers, or further a political agenda.

Reserves and production should not be confused. Reserves estimates are but one factor used in estimating future oil production from a given oil field. Other factors include production history, local geology, available technology, oil prices, etc. An oil field can have large estimated reserves, but if a well-managed field has past maximum production, the remaining reserves can only be produced at a diminishing rate. Sometimes declines can be slowed, but a return to peak production is impossible. This fundamental is not often appreciated by those unfamiliar with oil production, and it is often a major factor in misunderstanding the basic nature of oil production.

PRODUCTION PEAKING

World oil demand is forecast to grow 50 percent by 2025.[1] To meet that demand, ever-larger volumes of oil will have to be produced. Since oil production from individual oil fields grows to a peak and then declines, new fields must be continually discovered and brought into production to compensate for the depletion of older fields and to meet increasing world demand. If large quantities of new oil are not discovered and brought into production somewhere in the world, then world oil production will no longer satisfy demand. Peaking means that the rate of world oil production cannot increase; it does not mean that production will suddenly stop because there will still be large reserves remaining.

As indicated in Table I, some forecasters believe that world oil production peaking might occur very soon. Others argue that we may have more than a decade of plentiful oil.

Until recently, OPEC assured the world that oil supply would continue to be plentiful, but that position is changing. Some in OPEC are now warning that oil supply will not be adequate to satisfy world demand in 10-15 years.[2] Dr. Sadad al-Husseini,

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[1] U.S. Department of Energy, Energy Information Administration, *International Energy Outlook – 2004,* February 2004.

[2] Moors, K.F. *How Reliable are Saudi Production and Reserve Estimates?* Dow Jones

retired senior Saudi Aramco oil exploration executive, is on record as saying that the world is heading for an oil shortage; in his words "a whole new Saudi Arabia (will have to be found and developed) every couple of years" to satisfy current demand forecasts.[3] So the messages from the world's "breadbasket of oil" are moving from confident assurances to warnings of approaching shortage.

THE OIL PRICE-RESERVES NEXUS

In the past, higher prices led to increased estimates of conventional oil reserves worldwide. However, this price-reserves relationship has its limits, because oil is found in discrete packages (reservoirs) as opposed to the varying concentrations characteristic of many minerals. Thus, at some price, world reserves of recoverable conventional oil will reach a maximum because of geological fundamentals. Beyond that point, insignificant additional conventional oil will be recoverable at any realistic price. This is a geological fact that is often not understood by economists, many of whom are accustomed to dealing with hard minerals, whose geology is fundamentally different.

Oil companies and governments have conducted extensive exploration worldwide, but their results have been disappointing for decades. On this basis, there is little reason to expect that future oil discoveries will dramatically increase. The situation is illustrated in Figure 1, which shows the difference between annual world oil reserves additions and annual consumption.[4] The image is one of a world moving from a long period in which reserves additions were much greater than consumption, to an era in which annual additions are falling increasingly short of annual consumption. A related fact is that oil production is in decline in 33 of the world's 48 largest oil-producing countries.[5]

IMPACTS OF IMPROVED TECHNOLOGY AND HIGHER PRICES

Exploration for and production of petroleum has been an increasingly more technological enterprise, benefiting from more sophisticated engineering capabilities, advanced geological understanding, improved instrumentation, greatly expanded computing power, more durable materials, etc. Today's technology allows oil fields to be more readily discovered and better understood sooner than heretofore.

Some economists expect improved technologies and higher oil prices will provide ever-increasing oil production for the foreseeable future. To gain some insight into the effects of higher oil prices and improved technology on oil production, consider the history of the U.S. Lower 48 states. This region was one of the world's richest, most geologically varied, and most productive up until 1970, when production peaked and started into decline. Figure 2 shows Lower 48 historical oil production with oil prices and technology trends superimposed. In constant dollars, oil prices increased by roughly a factor of three in 1973-74 and another factor of two in 1979-80. In addition to these huge oil price increases, the 1980s and 1990s were a golden age of oil field technology development, including practical 3-D seismic, economic horizontal drilling, dramatically improved geological understanding, etc. Nevertheless, as Figure 2 shows, Lower 48 oil production still trended downward, showing no pronounced response to either price or technology. In light of this experience, there is no reason to expect that the worldwide situation will be different: Higher prices and improved technology are unlikely to yield dramatically higher conventional oil production.

Middle East Business Strategies. July 15, 2005.

[3] Haas, P. *The Breaking Point*. New York Times Magazine. August 21, 2005.

[4] Aleklett, K. & Campbell, C.J. *The Peak and Decline of World Oil and Gas Production.* Uppsala University, Sweden. ASPO web site. 2003.

[5] O'Reilly, D.J., Chairman and CEO, Chevron Corporation. Washington Post. July 25, 2005.

PEAKING OF WORLD OIL PRODUCTION

Various individuals and groups have used available information and geological tools to develop forecasts for when world oil production might peak. A sampling is shown in Table 1, where it is clear that many believe that peaking is likely within a decade.

MITIGATION

A recent analysis for the U.S. Department of Energy addressed the question of what might be done to mitigate the peaking of world oil production.[6] Various technologies that are commercial or near commercial were considered:

1. Fuel efficient transportation,
2. Heavy oil/Oil sands,
3. Coal liquefaction,
4. Enhanced oil recovery,
5. Gas-to-liquids.

It became abundantly clear early in this study that effective mitigation will be dependent on the implementation of mega-projects and mega-changes at the maximum possible rate. This finding dictated the focus on currently commercial technologies that are ready for implementation. New technology options requiring further research and development will undoubtedly prove very important in the longer-term future, but they are not ready now, so their inclusion would be strictly speculative.

A scenario analysis was performed, based on crash program implementation worldwide – the fastest humanly possible. The timing of oil peaking was left open because of the considerable differences of opinion among experts. Consideration of a number of implementation scenarios provided the following startling insights:

- Waiting until world oil production peaks before taking crash program action leaves the world with a significant liquid fuel deficit for more than two decades.

- Initiating a mitigation crash program 10 years before world oil peaking helps considerably but still leaves a liquid fuels shortfall roughly a decade after the time that oil would have peaked.

- Initiating a mitigation crash program 20 years before peaking offers the possibility of avoiding a world liquid fuels shortfall for the forecast period.

The reason why such long lead times are required is that the worldwide scale of oil consumption is enormous – a fact often lost in a world where oil abundance has been taken for granted for so long. If mitigation is too little, too late, world supply/demand balance will have to be achieved through massive demand destruction and shortages, which would translate to extreme economic hardship. On the other hand, with timely mitigation, economic damage can be minimized.

WARNING SIGNS

In an effort to gain some insight into the possible character of world oil production peaking, a number of regions and countries that have already past oil peaking were

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[6] Hirsch, R.L., Bezdek, R. and Wendling, R. *Peaking of World Oil Production: Impacts, Mitigation and Risk Management.* DOE NETL. February 2005.

recently analyzed.[7] Areas that had significant peak oil production and that were not encumbered by major political upheaval or cartel action were Texas, North America, the United Kingdom, and Norway. Three other countries that are also past peak production, but whose maximum production was smaller, were Argentina, Colombia, and Egypt.

Examination of these actual histories showed that in all cases it was not obvious that production was about to peak a year ahead of the event, i.e., production trends prior to peaking did not provide long-range warning. In most cases the peaks were sharp, not gently varying or flat topped, as some forecasters hope. Finally, in some cases post-peak production declines were quite rapid.

It is by no means obvious how world oil peaking will occur, but if it follows the patterns displayed by these regions and countries, the world will have less than a year warning.

IT'S NOT YOUR MOTHER'S ENERGY CRISIS

Oil peaking represents a liquid fuels problem, not an "energy crisis" in the sense that term has often been used. Motor vehicles, aircraft, trains, and ships simply have no ready alternative to liquid fuels, certainly not for the existing capital stock, which have very long lifetimes. Non-hydrocarbon-based energy sources, such as renewables and nuclear power, produce electricity, not liquid fuels, so their widespread use in transportation is at best many decades in the future. Accordingly, mitigation of declining world conventional oil production must be narrowly focused, at least in the near-term.

RISK MANAGEMENT

It is possible that peaking may not occur for a decade or more, but it is also possible that peaking may be occurring right now. We will not know for certain until after the fact. The world is thus faced with a daunting risk management problem. On the one hand, if peaking is decades away, massive mitigation initiated soon might be premature. On the other hand, if peaking is imminent, failure to quickly initiate mitigation will impose large near-term economic and social costs on the world.

The world has never confronted a problem like this. Risk minimization requires the implementation of mitigation measures well prior to peaking. Since it is uncertain when peaking will occur, the challenge for decision-makers is indeed vexing. Mustering support for an approaching invisible disaster is much more difficult than for one that is obvious.

POTENTIAL ECONOMIC IMPACTS OF OIL PEAKING

How bad might be the economic damage of world oil shortages? There is a paucity of analysis of the economic impacts of reductions in world oil supply. One study -- Oil Shockwave -- was performed by a group of credible former high-level government officials[8]. They concluded:

1. Given today's precarious balance between oil supply and demand, taking even a small amount of oil off the market could cause prices to rise dramatically. A roughly 4 percent (sustained) global shortfall in daily supply results in oil above $160 per barrel.

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[7] Hirsch, R.L. *Shaping the Peak of World Oil Production*. World Oil. October 2005.

[8] *Oil Shockwave Report Finds Severe Economic and National Security Risks From Small Global Oil Supply Disruptions*. National Commission on Energy Policy & Securing America's Future Energy. September 6, 2005.

2. Oil price shocks of this magnitude could do significant damage to the U.S. economy. In Oil ShockWave, the economy goes into recession and there are millions of fewer jobs as a result of sustained higher oil prices.

Oil Shockwave was focused on a multi-year drop of just 4% in oil supply. Major oil companies and others forecast oil declines of 4-8% per year – Yes, per year.

CONCLUDING REMARKS

Chinese officials have forecast the peaking of world oil production around the year 2012. As this committee knows, China has been making huge oil investments and procurement deals all over the world in recent years. They attempted to buy Unocal above market price. Indeed they are paying premium prices in many countries in order to secure future oil supplies.

It is possible that peaking may not occur for a decade or more, but it is also possible that peaking is occurring right now. We will not know for certain until after the fact.

Over the past century world economic development has been fundamentally shaped by the availability of abundant, low-cost oil. Previous energy transitions (wood to coal, coal to oil, etc.) were gradual and evolutionary; oil peaking will be abrupt and revolutionary.

The world has never faced a problem like this. Without massive mitigation at least a decade before the fact, the problem will be pervasive and long lasting.

Oil peaking represents a liquid fuels problem, not an "energy crisis" in the sense that term has been used. Accordingly, mitigation of declining world oil production must be narrowly focused, at least in the near-term.

A number of technologies are currently available for immediate implementation once there is the requisite determination to act. Governments worldwide will have to take the initiative on a timely basis, and it may already be too late to avoid considerable discomfort or worse. Countries that dawdle will suffer from lost opportunities, because in every crisis, there are always opportunities for those that act decisively.

ACKNOWLEDGEMENTS

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The Author

Robert L. Hirsch is a Senior Energy Program Advisor for SAIC and a consultant in energy. Previous employment included executive positions at the U.S. Atomic Energy Commission, the U.S. Energy Research and Development Administration, Exxon, ARCO, EPRI, and Advance Power Technologies, Inc. Dr. Hirsch is a past Chairman of the Board on Energy and Environmental Systems at the National Academies. He has a Ph.D. in engineering and physics from the University of Illinois.

Table I. Projections of the Peaking of World Oil Production

Projected Date	Source of Projection	Background & Reference
2006-2007	Bakhitari, A.M.S.	Oil Executive (Iran)[9]
2007-2009	Simmons, M.R.	Investment banker (U.S.) [10]
After 2007	Skrebowski, C.	Petroleum journal editor (U.K.) [11]
Before 2009	Deffeyes, K.S.	Oil company geologist (ret., U.S.)) [12]
Before 2010	Goodstein, D.	Vice Provost, Cal Tech (U.S.) [13]
Around 2010	Campbell, C.J.	Oil geologist (ret., Ireland)[14]
After 2010	World Energy Council	World Non-Government Org.[15]
2012	Pang Xiongqi	Petroleum Executive (China)[16]
2010-2020	Laherrere, J.	Oil geologist (ret., France) [17]
2016	EIA nominal case	DOE analysis/ information (U.S.)[18]
After 2020	CERA	Energy consultants (U.S.) [19]
2025 or Later	Shell	Major oil company (U.K.) [20]

[9] Bakhtiari, A.M.S. *World Oil Production Capacity Model Suggests Output Peak by 2006-07*. *Oil and Gas Journal*. April 26, 2004.
[10] Simmons, M.R. ASPO Workshop. May 26, 2003.
[11] Skrebowski, C. *Oil Field Mega Projects - 2004*. Petroleum Review. January 2004.
[12] Deffeyes, K.S. *Hubbert's Peak-The Impending World Oil Shortage*. Princeton University Press. 2003.
[13] Goodstein, D. *Out of Gas – The End of the Age of Oil*. W.W. Norton. 2004
[14] Campbell, C.J. *Industry Urged to Watch for Regular Oil Production Peaks, Depletion Signals*. *Oil and Gas Journal*.. July 14, 2003.
[15] *Drivers of the Energy Scene*. World Energy Council. 2003.
[16] Pang Xiongqi. *The Challenges Brought by Shortages of Oil and Gas in China and Their Countermeasures*. ASPO Lisbon Conference. May19-20, 2005.
[17] Laherrere, J. Seminar Center of Energy Conversion. Zurich. May 7, 2003
[18] DOE EIA. *Long Term World Oil Supply*. April 18, 2000. See Appendix I for discussion.
[19] Jackson, P. et al. *Triple Witching Hour for Oil Arrives Early in 2004 – But, As Yet, No Real Witches*. *CERA Alert*. April 7, 2004.
[20] Davis, G. *Meeting Future Energy Needs*. The Bridge. National Academies Press. Summer 2003.

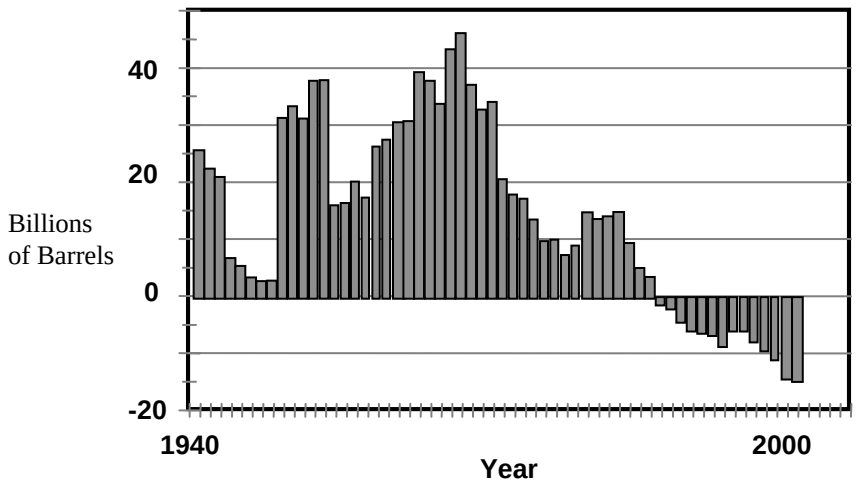

Figure 1. The net difference between annual world oil reserves additions and annual oil consumption has been declining for decades.

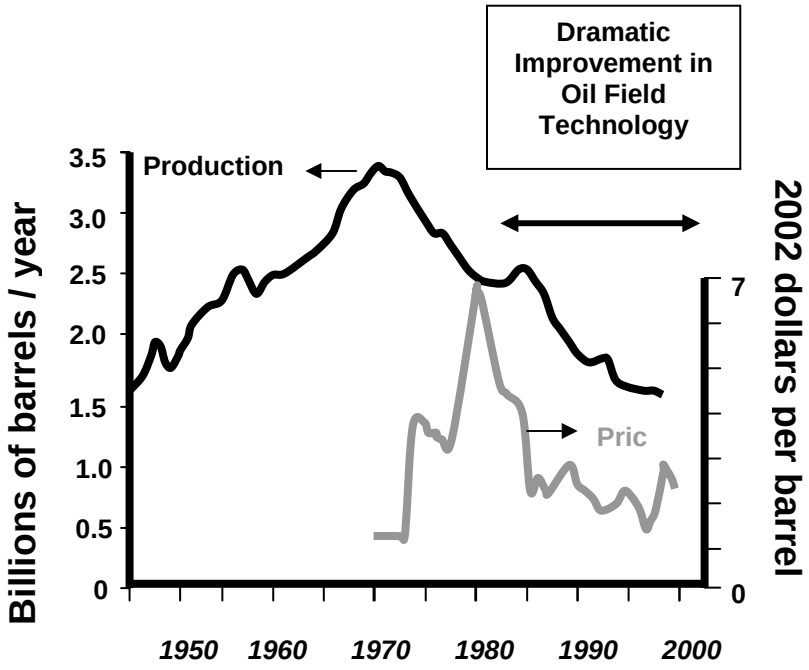

Figure 2. The decline of U.S. Lower 48 oil production was not reversed by large changes in oil prices or the dramatic improvement in oil field technologies.

MR. HALL. Thank you.

Mr. Esser?

MR. ESSER. Mr. Chairman and members of the committee, it is an honor for me to be here to address this committee on the critical issue of the nation's and world oil supply as the United States is inextricably bound up in a global marketplace.

We all recognize the importance of energy to our nation's future and the committee is to be commended for seeking to clarify and elucidate this important subject. As a nation, we have previously gone through periods of deep concern about the adequacy of energy supplies. Recently high prices, tight supplies, rapid demand growth, and political turbulence have all come together to put the spotlight on this question once again and have combined to create the urgency that is reflected in today's hearing.

The committee has asked us to address the question of Peak Oil. In our view, this is not a very helpful concept, nor one that provides much descriptive power. We at Cambridge Energy Research Associates have been conducting continuing research on the future of oil supplies, working up from a field by field basis in individual countries. Now that we are part of IHS, we can enhance our analysis by calling upon IHS's upstream oil field databases which are the largest and most complete in the world.

The following are our basic conclusions. One, the world is not running out of oil imminently, or in the medium term. Our field by field activity based analysis points to a substance build up of liquid capacity over the next several years. Two, an increasing share of supplies will come from non-traditional or unconventional oils from the ultra deep waters, from oil sands, from gas related liquids in which we include condensates and natural gas liquids and also the conversion of gas to liquids. Three, rather than an isolated peak, we should expect an undulating plateau, perhaps three or four decades from now. Peaking does not imply a precipitous decline towards running out. Four, one reason for the general pessimism about future supplies is that based on Cambridge Energy's reserve study, the reserve disclosure rules mandated by the Securities and Exchange Commission are based on decades old technology and need to be updated to reflect the new technology which is now available to verify reserves. Five, the major risk to this outlook, however, are not below ground geological factors but above ground geopolitical factors.

Let me now address these questions in more detail and specifically where we see growth coming from. The CERA outlook differs from others in that we are forecasting the capacity to produce. This is very important and it differs from actual production which can be affected by

such temporary disruptions as weather, accidents, maintenance, labor disputes, demand for poor quality oils, and economic cycles that affect demand. Recognizing the growing importance of unconventional liquids they are also included in our outlook and we also include oil from future discoveries. Most of these liquids are excluded from those outlooks calling for a near term peak.

Our sources of new supply: new capacity comes from the development of recent discoveries, older discoveries only recently made available – such as all of those huge fields now being developed in the Caspian Sea area – existing field reserve upgrades, and the drilling response to high prices which will tend to reduce decline rates in mature areas. Accordingly, the CERA outlook is a more optimistic picture than many of the other publicly available outlets and strongly contradicts those who believe Peak Oil is imminent.

Key trends: in our core scenario, which is at the high end of our expectations, CERA expects capacity could increase by as much as 15 million barrels a day to 102 million barrels a day by 2010. This is up from the 87 million barrels a day currently with a further increase of 6 million barrels a day to 108 million barrels by 2015. This is a 25 percent increase. All regions except the United States and the North Sea will show strong growth to 2020. Non-OPEC countries with strong growth in exports include Russia, Azerbaijan, Kazakhstan, Angola, Brazil, and Canada. Actually right now there is no more intense exploration in producing play than the Canadian oil sands. Strong growth takes place in both OPEC and non-OPEC countries till 2010, however, we also recognize that this will moderate by 2015.

Unconventional liquids will continue the strong growth exhibited since 2000 and are expected to comprise 30 percent of global capacity in 2010 and 35 percent in 2015. This is lead by gas related liquids associated with the gas under development to meet the soaring demand for liquefied natural gas, especially for the United States and other country and regional gas demand growth. The inclusion of these gas related liquids is certainly warranted as they too satisfy the demand of the liquid oil demand.

The increases in capacity are also underpinned by the development of the characteristic very large discoveries recently made in very deep waters since the late 1990's. The top ten discoveries alone each year add something on the order of 2 to 2-1/2 million barrels a day. Accordingly, CERA does not recognize a peak in oil capacity until at least 2030.

Why do we think the CERA outlook is correct? Well first of all, we utilize an activity based methodology that involves a rigorous bottom-up, field-by-field analysis of each significant country, including depletion and existing production, and a contribution from future discoveries based

on a forecasted pace of exploration in individual areas, and discovery results tailored to the current discovery results. Second, our long-term geology based experience is applied in analyzing oil field and related upstream matters. The expected strong near term growth of 5 million barrels a day that is projected to occur between 2004 and next year 2006 and 11 million barrels a day from 2004 to 2008 is sped by projects already sanctioned and under development lending support to the projected accelerated growth of liquids capacity. We also monitor the significance of recent discovery trends, including those in new areas such as India, Malaysia, the Sakhalin Island area, and Mauritania. We also have increased recognition by others and these are other people that are in this business and do this work of the increase in capacity that is underway.

What kind of eventual peak is envisioned? CERA envisions the eventual global liquid capacity peak as a multiyear undulating plateau followed by a long, slowly declining profile rather than an isolate peak followed by a rapid decline. This is similar to the pattern exhibited by individual fields, by regions, and by countries with their production profiles. We also have to look at what could slow the near term projected 15 million barrel a day increase in global liquid capacity by 2010. Many risks loom on the horizon that could impact productive capacity. Most of these are above ground risks such as severe lack qualified manpower and the shortage of rigs. Political risks occur in most OPEC countries especially in Iraq, Iran, Venezuela, and non-OPEC Russia. Other risks include access to areas of major under discovered reserve potential, a slowdown in the company sanction of new field development, and this is most important, an unexpected higher than assumed decline rate in some of the large Middle East fields, and lastly, delayed Government sanction of certain long awaited projects in Iran, Kuwait, and the UAE. Should many of these concerns take place in the near future, capacity in 2010 could be 5 million barrels a day lower than projected.

In summary, CERA expect accelerated growth in liquid oil supply by 2010, moderating somewhat by 2015. Through 2030, CERA does not see a peak in liquid capacity.

Thank you for you consideration of this testimony.

[The prepared statement of Robert Esser follows:]

PREPARED STATEMENT OF ROBERT ESSER, SENIOR CONSULTANT AND DIRECTOR, GLOBAL OIL AND GAS RESOURCES, CAMBRIDGE ENERGY RESEARCH ASSOCIATES

Mr. Chairman, Members of the Committee.

It is an honor to address this Committee on the critical issue of the nation's—and the world's—oil supply. We need a global perspective; after all, the United States is so inextricably bound up in a global marketplace. We all recognize the importance of energy to our nation's future, and the Committee is to be commended for seeking to clarify and elucidate this important subject. As a nation, we have previously gone through periods of deep concern about the adequacy of energy supplies. High prices, tight supplies, rapid demand growth, and political turbulence—all these have come together to put the spotlight on this question once again and have combined to create the urgency that is reflected in today's hearings.

The Committee has asked us to address the question of Peak Oil. In our view, this is not a very helpful concept, nor one that provides much descriptive power. Rather than an imminent "peak," we envision an "undulating plateau" two to four decades away. We at Cambridge Energy Research Associates have been conducting continuing research on future oil supplies, working up from a field-by-field basis. Now that we are part of IHS, we can enhance our analysis by calling upon IHS' upstream oil field data bases, which are the largest and most complete in the world.1

This is an issue that needs most serious consideration. After all, the planet has a finite resource, and the world is consuming 30 billion barrels a year. But the understanding of the situation that needs some clarification. Key considerations include technology, economics, timing, fiscal and regulatory terms, and a comprehensive understanding of current and future productive capacity. As we see it, the model for peak oil has been and continues to be flawed. The resource base is still poorly understood and it appears to continue to expand.

Our key points are as follows:

1. The world is not running out of oil in the near or medium term. Our field-by-field activity-based analysis points to a substantial build-up of liquid capacity over the next several years.
2. An increasing share of supplies will come from "non traditional oils"—from the ultra-deep waters, oil sands, natural gas liquids, gas-to-liquids, coal-to-liquids, etc. As time goes on, these "non-traditionals" will become more traditional.
3. Rather than a "peak," we should expect an "undulating plateau," perhaps three or four decades from now.
4. One reason for the pessimism about future supplies is that the reserves disclosure rules mandated by the Securities and Exchange Commission are based upon three decades old technology, and need to be updated. (We discuss this later in this written testimony).
5. The major risks to this outlook are not below ground, but above ground—in such forms as political turbulence, abrupt changes in contract terms, and controversy over fiscal terms.
6. Meeting the energy needs of a growing world in an environmentally-sound fashion will be a major challenge. Doing so will require substantial investment and continuing technological innovation and will more likely be achieved through an open global economy.

The most fundamental challenge facing the global oil industry is to increase oil production capacity. This challenge is not new. Indeed, rising prices and the current thin cushion of spare oil production capacity have resurrected an old worry: fear that the world is running out of oil. This has been a recurrent theme ever since the first oil well began production in Pennsylvania in 1859. It gathers steam and garners media attention about once every generation or so—particularly when oil prices are on the rise.

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[1] See Peter Jackson and Robert Essser CERA *Private Report*, *World Liquids Capacity Outlook to 2010: Tight Supply or Excess of Riches?*

Are we running out of oil? CERA's belief is that the world is not running out of oil imminently or in the near to medium term. Indeed, CERA projects that world oil production capacity has the potential to rise from 87 million barrels per day (mbd) in 2005 to as much as 108 mbd by 2015.2 After 2015 we see further growth in capacity. Our outlook contradicts those who believe that peak oil is imminent.

Although there have been recent downside factors such as the slowing rate of expansion of capacity in Russia and continuing problems in Iraq, this is balanced by a more positive outlook for major producing countries such as Angola and Brazil, where a stream of large projects continues. In addition to crude oil from conventional settings, our analysis concludes that unconventional oil—condensates, natural gas liquids (NGLs), deepwater production, extra heavy oils and gas-to-liquids (GTLs) will represent about 35 percent of total capacity in 2015— compared to 10 percent in 1990.

To be sure, many significant risks to production capacity loom on the horizon, but these are largely above-ground risks. Perhaps the greatest problem at present is the severe lack of qualified manpower resources and limits imposed by rig and yard availability and materials. At current high oil prices most oil companies want to increase activity levels, especially with existing producing fields, that will have a rapid return on investment, but increased competition has driven the cost of manpower and services higher. In addition, although we do not see a global peak in production capacity, the rate of growth in non-OPEC capacity will likely slow after 2010.

Political risks also have an impact on capacity expansion in the Middle East, where the situation in Iraq continues to be highly problematic, and there is growing uncertainty over events in Iran. In Russia, changes in ownership, the constraints of geology, and the fiscal and regulatory systems, as well as logistical bottlenecks and geological challenges – all these have led to the end of Russia's high supply growth era. In Venezuela fiscal and political changes have hindered the recovery of oil production and investment in the aftermath of the late 2002/early 2003 disruption and are likely to have continuing impact.

Our views about the peak oil debate have been reinforced by a detailed new audit of our own analysis and also further evidence that has come to light concerning the enormous scale of field reserve upgrades of existing fields. We also draw upon the proprietary databases of IHS, of which CERA is now part. These are the most extensive and complete databases on field production around the world. We see no evidence to suggest a peak before 2020, nor do we see a transparent and technically sound analysis from another source that justifies belief in an imminent peak. It will be a number of decades into this century before we get to an inflexion point that will herald the arrival of the "undulating plateau."

CERA's Methodology

CERA methodology generates an activity-based model that involves a rigorous bottom-up analysis of each country, for which we sum component capacity profiles for fields in production (FIP), fields under development (FUD), fields under appraisal (FUA), and a yet-to-find (YTF) component. Decline rates are built into this analysis. It is important to understand that we do not predict production as such, but rather capacity to produce, and that our assessment is lower than the industry aggregated total. We do not simply focus on crude oil alone, but encompass unconventional liquids including condensates, natural gas liquids (NGLs), heavy oils, and ultra deepwater oils. Many of the other projections available do not include all of these components, and this may explain why CERA's outlook is different. We also recognize that above-ground developments could lead to capacity growth's falling short of its potential.

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[2] Oil refers to crude oil, condensate, natural gas liquids (NGLs), and other sources of liquid hydrocarbons.

Major Trends and Signposts

Assuming no serious political crises in key producing countries or an unexpected shortfall in investment, global oil production capacity will continue to grow strongly toward 102.4 mbd by 2010 from the current level of 87.2 mbd. This expansion will be fairly evenly split between OPEC and non-OPEC countries: 8.5 mbd and 6.7 mbd, respectively. The expansion continues to 2015, but OPEC shows a greater increase: a net gain of 12.2 mbd (relative to 2005) versus 8.2 mbd for non-OPEC. At the regional level, the United States and North Sea show decreases to 2015 while Canada, West and North Africa, Latin America, and the Caspian, and the Middle East continue their current trend of strong expansion past 2010 and through 2015. Southeast Asia shows some modest growth, but declines after 2010. At the same time, Russian capacity growth slows.

By 2015 we also see a change in the geographic focus of the sources of liquids supply. The proportion of liquids capacity from the top 15 countries will rise from 58 percent in 2005 to 65 percent in 2015. While nearly every OPEC country, except Indonesia, shows potential for a significant increase to 2015, the sources of expansion in non-OPEC countries are more limited, with Russia, the Caspian nations, Brazil, Angola, and Canada leading the way. We also note the emergence of some new sources of liquids capacity both in the deep water, such as offshore Mauritania, and onshore in Sudan. In addition, mature areas such as Malaysia are reemerging and a new play is being successfully explored and developed in a previously unexplored deepwater area offshore Sabah, in northwest Malaysia. However, this shift in emphasis may prove to be to more politically and operationally challenging countries, which increases the levels of risk and supply anxiety in some consumer countries.

There are a large number of major projects in both OPEC and non-OPEC countries that underpin the increases. The top 10 projects being brought onstream each year will together add a cumulative gross capacity of 2.0–2.5 mbd per year until 2010 alone. These projects were approved under a much lower oil price regime, and even if the oil price falls significantly these projects will proceed. While there has been some slippage (e.g., Thunder Horse and Adar Yale), other projects began production ahead of schedule (e.g., Kizomba B, Whiterose).

Trends in Crude Quality and Unconventional Liquids

Analysis of the composition of new capacity shows that in the medium term there will be increasing proportions of light and heavy oils and a reduction in the proportion of medium grade crude. However, capacity additions to 2010 are predominately light (8 mbd), medium (5 mbd), and heavy (3 mbd) We also see a continuing rapid expansion of deepwater production capacity up to 2010, with a major surge from 3.4 mbd in 2005 to over 9 mbd by 2010. This surge will be dominated by growth from the "big four" deepwater areas: the US Gulf of Mexico, Brazil, Angola, and Nigeria, with more modest contributions from other areas.

Production capacity of extra heavy oil from Canada and Venezuela will expand from 1.8 mbd in 2005 to 4.9 mbd in 2015. Despite accidents earlier in 2005 the Canadian projects are moving forward at an accelerating pace. Expansion from 1.2 mbd currently to 3.4 mbd by 2015 is anticipated, with approximately half being mined and the remainder in situ. In Venezuela the four main Orinoco projects are onstream (totaling 650,000 bd) and with debottlenecking could reach 700,000 bd by 2010.

Between 2005 and 2015 there is considerable potential to expand total condensate plus natural gas liquids (NGLs) capacity from 14 mbd to 22 mbd.2 Notable condensate expansions will occur in Qatar as the liquefied natural gas (LNG) business expands and more gas is produced for pipeline exports and GTL conversion. One of the largest expansions of condensate capacity will occur in Norway. The story for NGLs is similar, with much of the expansion to 2010 occurring in many OPEC countries, including Saudi

Arabia, Qatar, and Nigeria. NGLs capacity in the United States will decline by 2010 in response to declining gas production.

Until recently the gas-to-liquids (GTL) business had contributed only a small proportion of production (160,000 bd in 2005), but there are a number of projects under way and planned that are expected to boost production capacity to 480,000 bd by 2010 and 1 mbd in 2015. This is a lower buildup than might be anticipated by summing the reports of current activity, but we expect that operators will not commit to new GTL projects until there is some certainty that the oil price will remain high on a sustained basis.[3]

OPEC Capacity Trends

Although most OPEC members are currently producing at or very close to capacity, they are in a strong position to expand total liquids production capacity to 49.9 mbd in 2015, with the proportion of condensates and NGLs rising by that time. Much of this expansion will tend to come from existing fields and discoveries rather than extensive new exploration. The key challenges are to understand the impact of decision making and political uncertainties on project execution and to take into account price trends that will influence the buildup of capacity over the next half decade.

- Saudi Arabia possesses the largest resource base in the world, with 268 billion barrels of proven reserves. Recent reports suggest that some 200 billion barrels of reserves is likely to be added. CERA believes that, in common with other countries around the Gulf, the exploration potential is still very high, despite the high level of existing proven reserves. While there has been much debate about Saudi Arabia's ability to expand production capacity, we see no comprehensive justification of claims that production is about to "fall off a cliff." We anticipate an expansion of crude and condensate capacity from 11.1 mbd in 2005 to as much as 13.2 mbd by 2015. Saudi Arabia is working to sustain its 1.5–2.0 mbd level of surge capacity while concentrating on increasing production of lighter and sweeter crude oil.
- Iran is making slow progress in expanding capacity, which currently stands at just under 4.2 mbd. With relatively high annual decline rates, delays in bringing new projects onstream, problems with existing projects (Soroush-Nowruz), and the changing internal and external political environment, the rate of expansion will slow compared to previous projections, but is still expected to reach 5.2 mbd by 2015.
- Iraq did not reach its goal of achieving production of 2.8 mbd by April 2004. It is currently producing 1.9 mbd and it is difficult to predict exactly when the situation will stabilize and allow new investment in the oil and gas sector. We believe that progress will be slow, with capacity reaching 2.8 mbd by 2010 and 4 mbd by 2015. Iraq has the potential for sustained liquids capacity in excess of 5 mbd and has major exploration potential. It will likely be a major player in OPEC expansion after 2010.
- Libya has reopened its doors to US oil companies following the lifting of sanctions. Presanction license holders have renegotiated their contracts. In addition, a number of successful licensing rounds have occurred and we anticipate that new discoveries will start feeding into the development queue by 2007/08. Meanwhile, there is a backlog of discoveries to develop and the possibility of enhancing production from some of the major fields that have seen very little investment for 20 years. Libyan production capacity will

[3] Condensate and natural gas liguids (NGLs) are gas-related liquids. Condensate is a gas at depth but a liquid at the surface. NGLs are liquids removed from rich gas by processing and consist of propane, butane, ethane, etc.

average 1.8 mbd in 2005 and climb fairly slowly to 2.5-3.0 mbd by 2015. The higher number depends on a successful exploration program combined with a focus on improved oil recovery projects. This is still early days for the reopening, and it remains to be determined how rapidly activity will pick up.

- Nigeria's deepwater projects finally appear to be moving forward. Exploration appears to be bearing fruit with the recent new discoveries. Expansion of production capacity to 4 mbd by 2010 from the current level of 2.9 mbd is strongly supported by current development activity, but problems with ethnic tensions and strikes will persist.
- Indonesian production capacity is dominated by small, mature fields that show high rates of decline. Despite progress with the negotiation of the Cepu project (170,000 bd by 2008) and other new projects, as well as major efforts to attract investment, we believe that Indonesia will struggle to expand capacity much above 1 mbd in the foreseeable future.
- Venezuelan capacity is expected to continue to grow slowly from 2.9 mbd in 2005 to 3.4 mbd by 2015, despite the huge resource potential. The Orinoco extra-heavy projects are currently contributing 650,000 bd. The sluggish recovery from the strike in 2002/03 is reflected by the continued slow increase in the number of active rigs and a slow buildup in investment. Also, changes in the investment and political climate will affect future levels of investment.
- United Arab Emirates crude plus condensate capacity is expected to expand from 2.9 mbd in 2005 to 3.5 mbd in 2015.
- In Kuwait expansion from 2.5 mbd to 3.5 mbd is expected between 2005 and 2015. The schedule for implementing Project Kuwait, aimed at increasing the production of Northern Fields from 600,000 to 900,000 bd, is not clear at this point.

Non-OPEC Capacity Trends

Non-OPEC countries have a considerable inventory of projects under way and planned by 2010. There are 80 projects with reserves greater than 100 million barrels and a further 120 with reserves above 20 million barrels due to come onstream before the end of 2008. Non-OPEC production capacity is set to rise to 56.3 mbd by 2010, with the rate of growth slowing after that point. Capacity has the potential to reach 57.8 by 2015. This apparent reduction in the rate of increase after 2010 could be real, but could also reflect the less clarity in that time period as to our lack of knowledge which projects are likely to be developed, given that our Supply Expansion outlook is an activity-based model.

- Brazil. Current production capacity of 1.8 mbd is set to expand to 2.9 mbd by 2010. With new projects coming on stream, and with the recent successful Seventh Licensing Round and continued exploration success, we envisage continued expansion in total production capacity well past 2010.
- Angola. Capacity is expected to expand rapidly from current levels of 1.3 mbd to 2.5 mbd by 2010. The string of deepwater discoveries in Angola continues. Developments in Angola, Nigeria, and elsewhere in the region will push West African liquids capacity up to 9.2 mbd in 2015, from 6 mbd in 2005.
- United Kingdom. The United Kingdom is typical of a mature basin that is past its geometric peak of oil production. Indeed, there were two peaks, in 1985 and 1999, which marked a plateau lasting more than 15 years. Capacity is now on a broadly declining trend despite the relatively high levels of activity. However, at the current high oil prices, and capitalizing on the extensive mature infrastructure, many small (less than 20 million barrels of oil equivalent) projects are being developed and helping to arrest the decline. Occasional major discoveries are still made in the United Kingdom, and a discovery on the Atlantic Margin could be developed soon after 2010. Even so, the overall trend

is lower, and by 2015 we anticipate production capacity of 1.24 mbd (down from 2.09 mbd in 2005).

- Norway shows some slight positive momentum for capacity in the short term, but with current rates of success and an inventory of relatively small discoveries to develop, CERA predicts that production capacity will decline from 3.3 mbd in 2005 to 2.3 mbd in 2015. Interest in the Norwegian continental shelf is undiminished, as reflected by the recent APA (awards in predefined areas) licensing round and the increasing number of companies seeking to qualify to invest. If these and other recent awards yield exploration wells, we could see liquids capacity expanding past 2010. The project aimed at prolonging the life of the Statfjord field to 2020 is now under way, and other mature fields (e.g., Draugen) are being short-listed for similar late life interventions.
- United States. Supply disruption from the 2005 hurricane season could run well into 2006. Currently roughly 540,000 bd of oil production remains shut in, with as much as one third to be shut in well into 2006. Also it is estimated that less than 25,000 bd of capacity will be permanently lost from the destruction of old facilities. Disruption of gas supply has resulted in a fall in NGLs production. These factors will slow new project start-ups in the short term, exacerbating the existing problem with the Thunder Horse facility, which will now probably not produce until late in 2006. US liquids capacity is expected to fall from 7.5 mbd in 2005 to 7 mbd in 2010.
- Canada. Major expansion is expected. The main story is the oil sands projects, where capacity is expected to increase from 1.2 mbd in 2005 to 2.4 mbd by 2010 and 3.4 mbd by 2015. Conventional crude capacity of 2.3 mbd will decline to 1.9 mbd by 2015.
- Russia. Although we have adjusted the rate of growth of Russian capacity downward in the light of recent events, production is holding up and has actually increased to 9.6 mbd recently, and will be buoyed through 2006 by the start-up of Sakhalin-1 this year. After a number of years of rapid expansion Russia is moving back to slower long-term liquids capacity growth rates. There is much debate as to the reasons for the slowdown, and certainly multiple factors are at work, but none of these are a shortage of resources in the ground 3.4
- Caspian region. Progress continues with the completion of the Baku-Tbilisi-Ceyhan pipeline and solid progress with the ACG field development in Azerbaijan. In Kazakhstan, the giant Kashagan field may be delayed by a year to 2010, but we expect total Caspian production capacity to rise strongly from current levels of 2.2 mbd to 4.2 mbd in 2010 and 5.3 mbd in 2015.

What Could Go Wrong?

CERA's outlook for growth in oil production capacity incorporates elements of risk involving existing project problems, annual maintenance, new project delays and attrition, and the timing and scale of appraisal and exploration projects. But there is another group of major risks that will materialize. While there is uncertainty about decline rates and the scale of contributions from new projects and exploration, CERA believes the risks to capacity expansion are mostly above ground: People, rigs, yard space, and raw materials are in very short supply; costs have been driven up; and the situation shows no sign of easing. This will limit the expansion of the exploration effort and slow the rate at which new projects will be sanctioned. Other above ground risks are

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[4] See the John Webb, Konstantin Kovalenko, and Thane Gustafson CERA *Private Report, Why is Russian Oil Production Slowing Down?*

- Operational risks exist, especially in extreme environments such as ultra deep water where the cost base and the subsurface risks are also higher.
- Weather and environmental effects can be broad and unpredictable. The impact of Hurricanes Katrina and Rita are still being felt in the US Gulf Coast, where some 0.54 mbd of production is still shut in.
- Creeping nationalization and reconsolidation is occurring in key producing countries.
- Resurgent nationalism in some countries is creating considerable turmoil and increased risks for both international oil companies (IOCs) and the now better-positioned national oil companies (NOCs).
- Tightening fiscal terms in response to higher oil prices and policy changes where governments and NOCs do not see inward investment as absolutely essential are an ongoing risk.
- Violence and insecurity is having an impact on production capacity in some areas.

The Specter of Peak Oil: What Peak?

The question of a worldwide peak in oil production continues to stimulate debate. Our outlook shows no evidence of a peak in worldwide oil production before 2020. It is true that total annual global production has not been replaced by exploration success in recent years, but production has been more than replaced by exploration plus field reserve upgrades. In 1995–2003 global production of 236 billion barrels was more than compensated by exploration success and field upgrades that collectively added 144 billion barrels and up to 175 billion barrels, respectively. Although oil is a finite resource, we still do not have an exact estimate of total reserves; meanwhile global resources should continue to expand. Many basins, even those producing significant volumes of oil, remain underexplored.

CREATING A RELIABLE DATA SET

One of the reasons that there is so much debate over the whether the peak of oil production is imminent or not is that different observers rely upon different data sets. The most visible data are those published by E&P companies through their annual reports and the most extensive collection of such reports are the filings under United States Securities and Exchange Commission (SEC) rules for companies with securities listed in the US. However these data are overly conservative as evidenced by the extent to which upward reserve revisions outweigh downward revisions. As we noted earlier, while new exploration on its own has not replaced global production, revisions of earlier estimates have created a net gain in reserves despite production. Among other things, this structural bias provides less useful information to investors and sets a misleading baseline for estimating future oil (and natural gas) supplies.

Earlier this year, CERA published its Special Report In Search of Reasonable Certainty, marking the culmination of some nine months of research into whether and how the definitions of proved reserves promulgated by the SEC needed to be updated. One of the key conclusions of this work was that the rules were stranded in time—representing a vision of the industry rooted in the technologies and structures of the 1970s. The result is that large portions of discovered fields maybe excluded from disclosure until later in their producing lives and that only a small portion of the overall picture is revealed by these disclosures. As often happens with regulatory systems that have been in place for three decades, it requires modernization to take into account almost revolutionary changes in technologies, and transformations in terms of market structure and geography. When the rules were promulgated, the government set U.S.oil and gas prices, there were no global markets for natural gas, and the deepwater frontier was 600 feet (compared to today's 12,000 feet).

CERA has been conducting further study around ways in which the excessively conservative structural bias of these disclosures could be corrected and expects to publish the results of this work early in the New Year. However, the strong conclusion is that it is only by separating the roles of standard setting from compliance monitoring that progress can be achieved. The most widely accepted definitions for oil and gas reserves are those of the Society of Petroleum Engineers-.

If the SEC were to adopt the SPE definitions and guidelines, this would lead to the creation of a globally consistent data set that covered the vast majority of the world's oil and gas reserves. As the very definition of what is oil begins to change with the addition of non-traditional resources such as syncrudes and GTLs and even liquid fuels made from coal, a reliable dataset will be even more vital to inform the debate about when the world may face an undulating plateau of global oil production.

Robert W. Esser, CERA Senior Consultant and Director, Global Oil and Gas Resources at Cambridge Energy Research Associates (CERA), is an authority on worldwide oil and gas productive capacity, and on global exploration and producing activity. For the past 15 years, he has led CERA's work on upstream activity, prospects for existing world oil production, the significance of recent discoveries, the pace of future discoveries and their influence on future productive capacity, and North American natural gas supply. Prior to joining CERA, he was the Mobil Oil expert responsible for energy resource and oil and gas supplies projections, used by Mobil both for crude price forecasts and as a basis for the exploration and production strategy. Mr. Esser is a member of the American Association of Petroleum Geologists (AAPG) and a trustee of the AAPG Foundation.

Mr. Esser is the author of many CERA studies. His current reports include: *World Liquids Capacity Outlook to 2010: Tight Supply or Excess of Riches?* (with Peter Jackson) and *The North American Gas Supply Challenge—The Role of the Gulf of Mexico.* Other recent studies include *The Capacity Race: The Future of World Oil Supply; Western Canada's Oil Sands—Promise Fulfilled at Last?;* and *The Flexure Trend in the Gulf of Mexico: A Panacea for Future US Oil and Gas Production?;* among others.

He holds two degrees in geology, a BS from Yale University and an MS from Stanford University.

MR. HALL. I thank you, Mr. Esser.

Mr. Smith, the committee, Mr. Smith will not probably be back. He is at the Canadian Embassy on some type of emergency. We have his statement and without objection I will put it in the record. Is there objection? The chair hears none.

[The prepared statement of Murray Smith follows:]

PREPARED STATEMENT OF MURRAY SMITH, MINISTER—COUNSELLOR GOVERNMENT, CANADIAN EMBASSY

Overview

The Government of Alberta, Canada, is pleased to provide this submission on the Alberta Oil Sands to the U.S. House Subcommittee on Energy and Air Quality.

Included is a brief description of the Province of Alberta; our role in North American energy security; the extent of oil sands resources in Alberta, including reserves based on

currently available extraction technologies; the role the Government of Alberta plays in bringing these valuable resources to market; and, the direct effect this has had on investment, production and development-including new technologies. Production of crude oil from Alberta's oil sands will continue to ensure Canada remains the primary supplier of energy to the U.S. The major points to be made through this submission are listed below:

The Government of Alberta does not have an official opinion regarding the theory of "Peak Oil."

Conventional oil production from the Western Canadian Sedimentary Basin (WCSB) peaked in 1997; Alberta conventional oil production"peaked" in 1973 at 1.3 million barrels per day. Today Alberta produces just over 2 million barrels a day and will grow to 2.5 million in three to four years and about 3 million barrels per day before 2015.

Alberta is recognized as the home of the second largest oil reserves in the world. From initial reserves in place of 1.7 trillion barrels of oil, there are currently 174.5 billion barrels of oil in established reserves and 315 billion barrels believed to be ultimately recoverable.

Alberta crude oil production from oil sands is currently in excess of 1 million barrels per day (bbl/d). Production is anticipated to reach 3 million bbl/d by 2015, and 5 million bbl/d by 2030.

Alberta is a significant contributor to the energy security of the United States, currently supplying 12% of U.S. crude oil imports and 12% of U.S. natural gas consumption.

The people of Alberta own the province's natural resources, which are administered, managed and regulated on their behalf by the Government of Alberta.

Currently a significant amount of conventional oil and gas is being left in the ground. With technological improvement it is believed that additional reserves of 5 billion barrels of conventional oil, 25 trillion cubic feet (Tcf) of conventional natural gas and 100 Tcf of unconventional natural gas, can be produced in Alberta.

Alberta will continue to be a significant energy producer through ongoing production of conventional oil and natural gas, oil production from oil sands, the development of "unconventional" natural gas resources, and the development of clean-coal technologies. There remains significant scope for additional refining capacity within the province.

The Government of Alberta, Canada, is pleased to provide this written submission on the Alberta Oil Sands to the US Subcommittee on Energy and Air Quality.

Included is a brief description of the Province of Alberta; our role in North American energy security; the extent of oil sands resources in Alberta, including reserves based on currently available extraction technologies; the role the Government of Alberta plays in bringing these valuable resources to market; and, the direct effect this has had on investment, production and development-including new technologies. Production of crude oil from Alberta's oil sands will continue to ensure Canada remains the primary supplier of energy to the U.S.

The Province of Alberta

Albertans are a breed apart. They are driven by the pioneering spirit that first settled the land. They hold dear the ethics of hard work and personal responsibility. They cherish the ideals of family and community that built the province.

Our policies focus on free trade and competitive markets as the best way to allocate scarce resources. Provincial law prevents the government from subsidizing any commercial business entity. The Province has no sales tax, a 10% flat personal income tax, and no debt – something that has not been achieved anywhere else in Canada, and something of which Albertans are justifiably proud.

Year after year, Alberta's economic growth leads Canada, averaging 3.7% annually over the past 10 years. We lead the nation in job creation, and our unemployment rate is

consistently among the lowest in Canada. Alberta's per capita disposable income and standard of living are the highest in Canada. Not surprisingly, we continue to experience the strongest population growth in Canada, with people from all over Canada and around the world migrating to our province to experience the Alberta Advantage for themselves and their families.

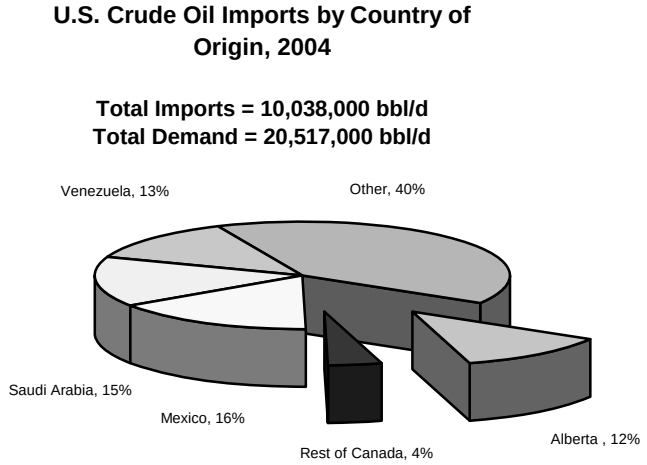
North American Energy Security

Alberta is rich in hydrocarbon resources – producing almost 2 million barrels per day of crude oil, and 13.8 billion cubic feet per day of natural gas. The province also produces 30.9 million tons of coal per year, from a proven reserve base of 37.5 billion tons. Alberta government and industry remain hopeful that significant Natural Gas from Coal (NGC) and clean coal developments will ultimately compose a significant portion of the province's energy mix.

Alberta is vital to the energy security of the United States – we are reliable, secure and, importantly, stable suppliers of energy to the US. In 2004, for the sixth year running, the US Energy Information Administration recognized Canada as the largest supplier of oil (crude and refined) to the US, with the bulk of this coming from Alberta.

Approximately 12% of US crude oil imports and 12% of its natural gas consumption come from Alberta alone.

Figure 1: USA 2004 Crude Oil Imports by Country of Origin



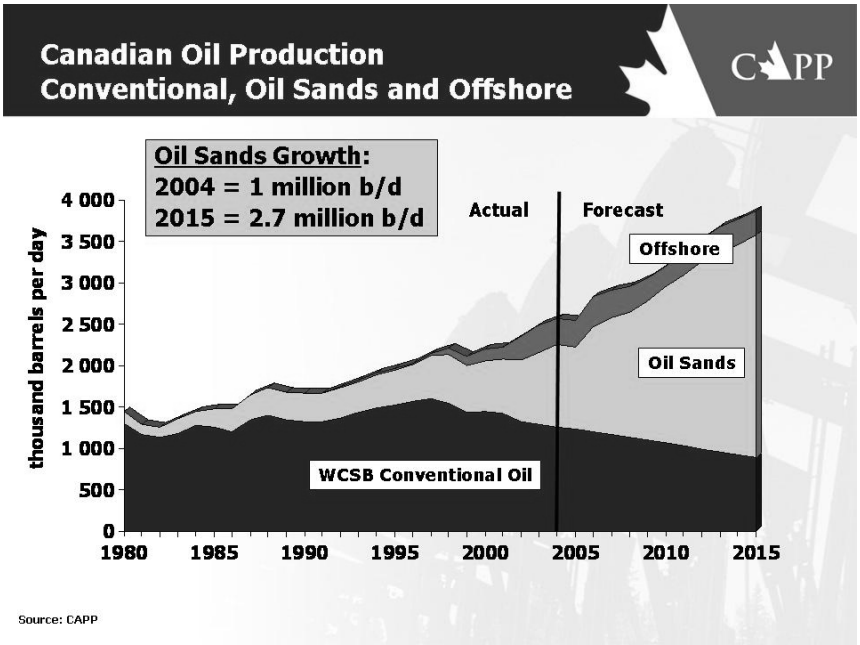
Alberta's Oil & Gas Industry and the Province's first 'Peak'

Oil was first discovered in Alberta in 1914 at Turner Valley, southwest of Calgary; however, it was the 1947 oil discovery at Leduc that radically transformed the province from a primarily rural and agricultural province, to the center of Canada's oil and gas industry and a recognized world leader in oil and gas technology development and innovation.

Conventional oil production, combined light and heavy crude, peaked in the Western Canadian Sedimentary Basin (WCSB) in 1997 and has been steadily, albeit slowly, declining ever since. Conventional crude oil production in Alberta actually peaked in 1973, with daily production of 1.3 million bbl/d. Despite this "peak" in conventional oil production, total Alberta production of crude oil has been steadily increasing and is

projected to make significant gains over the course of the next several decades. The reason for this overall increase in oil production has been the remarkable success of oil sands development. In 2001, crude production from oil sands exceeded conventional crude production in the province and currently over one-half of Alberta's oil production is derived from oil sands. Within the next decade it is anticipated that crude production from oil sands will provide upwards of seventy-five percent of Alberta's total production. Annual oil sands production is growing steadily by about 200,000 -250,000 barrels per day (bbl/d) per year, as the industry matures.

Figure 2: Canadian Oil Production, 1980 - 2015

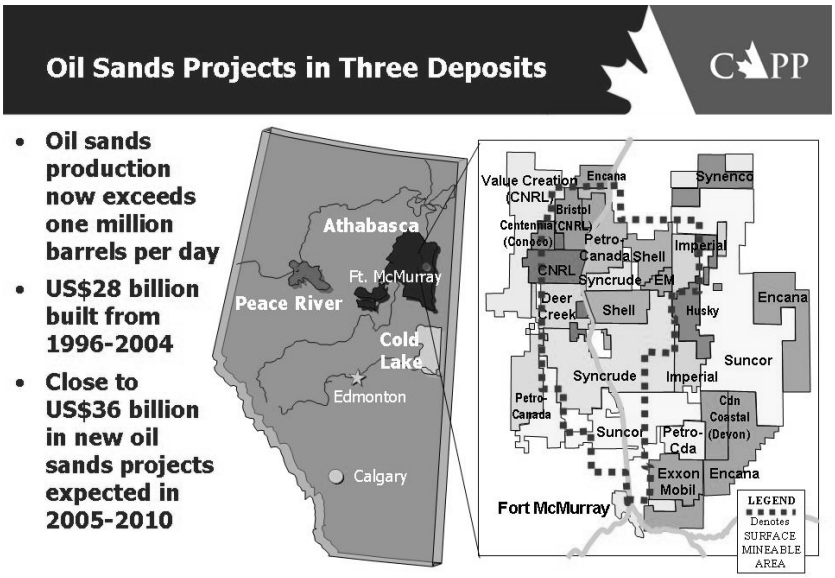


What are oil sands?

Oil sands are deposits of bitumen, a molasses-like viscous oil that requires heating or dilution with lighter hydrocarbons in order to flow. Second only to the Saudi Arabian reserves, Alberta's oil sands deposits have been described by Time Magazine as "Canada's greatest buried energy treasure," which "could satisfy the world's demand for petroleum for the next century."

Deposits are found in three major areas in northeastern Alberta: Peace River, Athabasca (Fort McMurray area), and Cold Lake (north of Lloydminster), totaling approximately 54,400 square miles – an area larger than the state of Florida.

Figure 3: Alberta Hydrocarbon Resources



Source: Canadian Association of Petroleum Producers

Size of Alberta Oil Sands Reserves

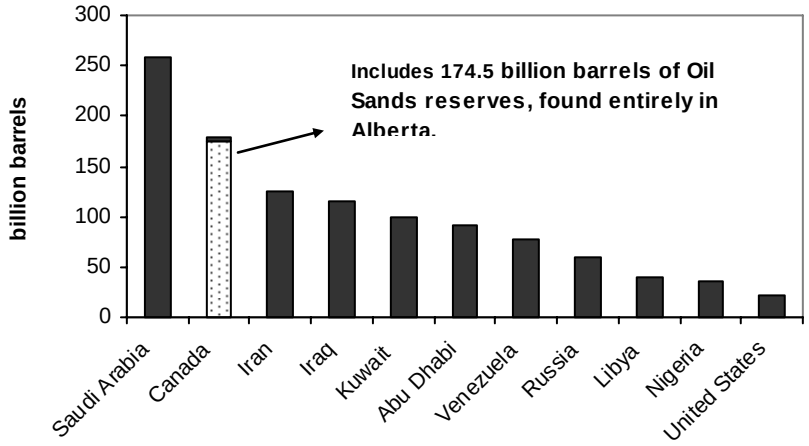
Alberta is home to the largest oil sands reserves in the world with established reserves of 174.5 billion barrels.

Established Reserves	174.5 billion barrels
Ultimate Potential Reserves	315 billion barrels
Initial In-Place Reserves	1.7 trillion barrels

This data is on the public record and confirmed by the Alberta Energy & Utilities Board (AEUB), an arms-length regulatory agency. Over 56,000 wells and 6,000 cores were the basis of the analysis.

In December 2002, these figures were recognized by the Oil & Gas Journal, followed by the US Energy Information Administration in 2003.

Figure 4: Proven World Reserves (Oil & Gas Journal, Dec 2004)



Production Methods: Mining and In-Situ

There are two methods of oil sands production methods: mining and in-situ. Oil sands mining involves open pit operations. Oil sands are moved by trucks and shovels to a cleaning facility where the material is mixed with warm water to remove the bitumen from the sand. Today, all operating oil sands mines are linked with upgraders that convert the bitumen to synthetic crude oil.

For oil sands reservoirs too deep to support economic surface mining operations, some form of an in-situ or "in place" recovery is required to produce bitumen. In-situ oil sands production is similar to that of conventional oil production where oil is recovered through wells. Present operating costs, not including capital recovery, vary between $10-15/per barrel.

The AEUB estimates that 80% of the total bitumen ultimately recoverable will be with in-situ techniques. In general, the heavy, viscous nature of the bitumen means that it will not flow under normal conditions. Numerous in-situ technologies have been developed that apply thermal energy to heat the bitumen and allow it to flow to the well bore. These include thermal (steam) injection through vertical or horizontal wells such as cyclic steam stimulation (CSS), pressure cyclic steam drive (PCSD) and steam assisted gravity drainage (SAGD). Other technologies are emerging such as pulse technology, vapor recovery extraction (VAPEX) and toe-to-heel air injection (THAI).

In general, oil sands mines operations are found in central Athabasca deposits (around Fort McMurray). In-situ production is used in the Cold Lake, south Athabasca and Peace River deposits.

Government Framework

The mineral rights in approximately 97% of Alberta's 54,000 square miles of oil sands area are owned by the Government of Alberta (i.e., state-level) and managed by the Alberta Department of Energy. The remaining 3% of the oil sands mineral rights in the province are held by the federal Government of Canada (i.e., federal-level) within First Nation reserves, by successors in title to the Hudson's Bay Company, by the national railway companies and by the descendents of original homesteaders through rights granted by the Government of Canada before 1887. These rights are referred to as "freehold rights".

The Alberta government departments of Environment and Sustainable Resource Development administer complementary environmental policies. The Alberta Energy & Utilities Board (AEUB) regulates oil and gas activities in the province.

The Alberta Department of Energy is responsible for administering the legislation that governs the ownership, royalty and administration of Alberta's oil, gas, oil sands, coal, metallic and other mineral resources. The Department's main objective is to manage these non-renewable resources to ensure their efficient development for the greatest possible benefit to the province and its people.

Oil Sands Royalty Structure

In 1996, Alberta announced a new generic royalty regime for oil sands based on recommendations from a joint industry/government National Oil Sands Task Force (NOSTF). This regime is defined in the Mines and Minerals Act and the Oil Sands Royalty Regulation 1997, as amended (OSRR 97). Royalty is calculated using a revenue-less-cost calculation.

In early project years before capital investment and other costs are recovered, the royalty rate is lower than the rate that is applied after costs are recovered. This helps project cash flows in early years. Once costs are recovered, the Province shares in project profits.

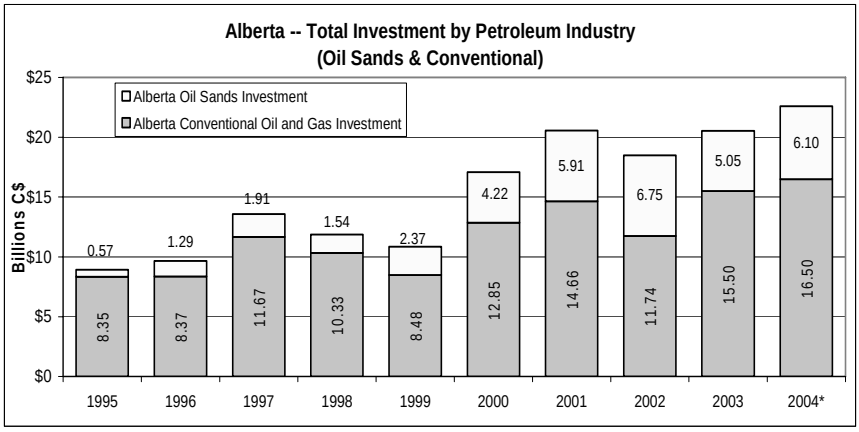
- In the pre-payout period (before the project has recovered all of its costs), projects pay royalty tied to 1% of gross revenue;
- In the post-payout period (after the project has recovered all of its costs), projects pay royalty tied to the greater of 1% of gross revenue or 25% of net revenue.

Since 1990, oil sands royalties have totaled over $2.5 billion.

Announced Investment

Since 1996, when the generic royalty regime was introduced, there has been an estimated $35 billion of investment in the oil sands. It is expected that new capital investment in the oil sands could range from $2.5 - $4 billion per year. Looking forward, the oil sands industry will command a far greater share of investment compared to the conventional oil ands gas sector. An inventory of major projects (valued at $2 million or greater) compiled by the province shows oil sands investments underway or announced exceed $70 billion, while conventional oil and gas investments are valued at just over $4 billion.

Figure 5: Total Investment in Petroleum Industry in Alberta



*Estimate as of June 2005. Source: Canadian Association of Petroleum Producers.

Figure 6: Oil Sands Projects Planned and Under Construction, by Company / Consortium as of September 2005

SPONSORS	COST (US$)
Albian Sands Energy Inc.	4,500 million
BA Energy Inc.	800 million
Blackrock Ventures Inc.	340 million
Canadian Natural Resources Ltd.	10,750 million
Connacher Oil and Gas	150 million
ConocoPhilips / TotalFinaElf / Devon Energy	1,400 million
Devon Canada Corporation	950 million
EnCana Corporation	1,859 million
ExxonMobil Canada	1,500 million
Husky Energy Inc.	3,200 million
Imperial Oil Ltd.	850 million
Imperial Oil Resources	650 million
Imperial Oil Resources / ExxonMobil Canada	5,000 million
Japan Canada Oil Sands Ltd.	450 million
North West Upgrading Inc.	1,300 million
OPTI Canada Inc. / Nexen	3,482 million
Pacific Energy Partners	4 million
Petro-Canada / UTS Energy Corporation	37 million
Petro-Canada / UTS Energy Corporation / Teck Camino	2,000 million
Petro-Canada	1,600 million
Petro-Canada / Nexen	800 million
Suncor Energy Inc.	11,050 million
Syncrude Canada Ltd.	12,300 million
SynEnCo Energy Inc. / SinoCanada	4,500 million
Total Canada Ltd.	1,678 million
Whitesands In Situ Ltd.	44.7 million
TOTAL	**71,194.7 million**

Source: www.alberta-canada.com Major Projects Inventory.

The Way Forward

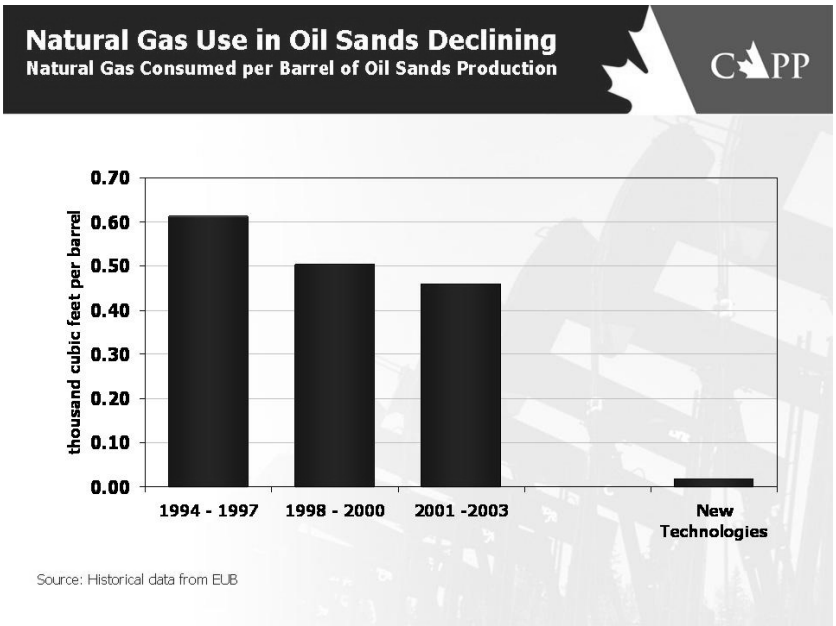
To date, only about 2% of the established oil sands resource has been produced. Alberta's oil sands industry is the result of multi-billion-dollar investments in infrastructure and technology required to develop the non-conventional resource. In the last five years alone, industry has allocated an estimated $28 billion towards oil sands development, and the Government of Alberta invested over $700 million over a 20-year period.

Alberta encourages the responsible development of these extensive deposits through planning and liaison among government, industry and communities to ensure a competitive royalty regime that is attractive to investors, appropriate regulations and environmental protection and the management of the Province of Alberta's rights to oil sands while taking into account some of the barriers - higher technological risk and higher capital costs - faced by oil sands developers.

In 2004 Alberta's oil sands were the source of over half of the province's total crude oil and equivalent production and over one third of all crude oil and equivalent produced in Canada. Over the last three fiscal years, through to 2003/2004, oil sands development returned $565 million to Albertans in the form of royalties paid to the Provincial government.

Continuing technology improvements will lead to greater energy efficiency and a reduction in natural gas as a fuel input source. As the future unfolds, the only impediment to oil sands production could be shortages of skilled labour to complete the projects. Oil sands projects will compete for the same skilled workforce as the Mackenzie and Alaska natural gas pipelines.

Figure 7: Natural Gas Consumed per Barrel of Oil Produced (CAPP Chart based on data from the EUB)



Development of Alberta's oil sands resources represents a triumph of technological innovation. Over the years, government and industry have worked together to find innovative and economic ways to extract and process the oil sands and energy research is more important today than ever before. Working through the Alberta Energy Research Institute, the Alberta government is committed to a collaborative approach with counterparts in Canada and the United States to spur new technology and innovation programs that will reduce the impact of greenhouse gases and other emissions, and reduce the consumption of water and gas.

Reversing the Peak

In addition to the significant gains being realized by the oil sands, there is an opportunity, through improved technology, to increase the ultimate recoverable conventional oil and natural gas in the WCSB. The Alberta Energy Research Institute (AERI) estimates that roughly three quarters of the conventional oil and slightly less than half of the natural gas in the province is currently being left in the ground. (Report: Spudding Innovation Accelerating Technology Development in Natural Gas and Conventional Oil http://www.ptac.org/techinnp.html) There is consensus that an ample supply of petroleum remains in Alberta: 47 billion barrels of conventional oil, 147 trillion cubic feet (Tcf) of conventional natural gas and as much as 1,000 Tcf of unconventional gas. AERI estimates that through the deployment of advanced enhanced recovery technologies 5 billion additional barrels of conventional oil, 25 Tcf of additional conventional natural gas, and 100 Tcf of unconventional gas can be produced and brought to market in the coming decades.

It is also believed that much of the increase in conventional production can be facilitated through ongoing developments in the oil sands sector. One means of

increasing conventional oil production is achieved by injecting carbon dioxide (CO_2) into a well in order to displace additional hydrocarbons. There is currently an industry-led plan in development to capture CO_2 emissions from the oil sands, transport it via pipeline to Alberta's conventional oil fields and inject it into existing reservoirs to increase production. Of added benefit to this plan will be the reduction in CO_2 released into the atmosphere.

It is understood that as crude oil production in Alberta grows, so too will opportunities for additional value-added activities, including scope for growth in the province's refining capacity. Over the past two years the Hydrocarbon Upgrading Task Force (HUTF), consisting of 30 private sector companies and Alberta's ministries of Energy and Economic Development, has developed Vision 2020. This vision assumes increased bitumen production from the current 1 million bbl/d, to 3 million bbl/d by 2020, and 5 million bbl/d by 2030, and that the value of this output can be greatly increased by upgrading or refining a large portion of this production in the province.

APPENDIX 1

Murray D. Smith
Minister-Counsellor, Government of Alberta
Embassy of Canada, Washington DC

Murray Smith was appointed in January, 2005, as the Official Representative of the Province of Alberta to the United States of America. He leads the newly established Alberta Office in Washington, D.C, co-located in the Canadian Embassy.

Prior to his diplomatic posting, Murray served for twelve years as a Member of the Legislative Assembly in the Province of Alberta, Canada (winning three consecutive elections in Calgary, Alberta). Premier Ralph Klein (the provincial leader) appointed him to four different Cabinet portfolios – Energy, Gaming, Labour, and Economic Development.

As Minister of Energy (2001 to 2004), Murray was responsible for gaining international recognition of Alberta's 176 billion barrels of established oil reserves -- including 174 billion barrels of oil sands reserve. During his tenure, Alberta annual oil and gas royalty revenue rose to over $9 billion, a record number of wells were drilled (over 20,000), and over $60 billion in investment was committed to Alberta oil sands projects. Murray was also responsible for Alberta's electricity sector, guiding the $5 billion market move to competitive wholesale generation. Increased investment added over 5000MW in new generation, and Alberta became the top wind generation province in Canada.

Murray also served as Minister of Gaming (1999 to 2001) and Minister for Labour (1996 to 1999). And in his first Cabinet-level post, as Minister of Economic Development (1994 to 1996), he initiated the largest industrial tax reduction in the province's history. He was a member of the Cabinet Committee Treasury Board and a main contributor to the province's Debt Retirement Plan, which led the province to become the first debt-free jurisdiction in Canada.

Before serving Albertans as an elected Member of the Alberta Legislature in 1993, Murray was an independent businessman. He owned and started a number of Alberta-based energy and retail companies.

Murray is a contributor to many community organizations as well as to the University of Calgary, where an endowment has been established in his name. He is the recipient of numerous awards and is a past Director of the Calgary Stampede Board.

He is a graduate of the London Business School's Senior Executive Program. He also holds a B.A. (Economics & Political Science) from the University of Calgary, and he is a graduate of Notre Dame College in Wilcox, Saskatchewan and a past President of the College's Alumni Association.

Murray has been married to Barbara Smith for 35 years and has two daughters. He is an avid, though unskilled, golfer and a lifetime member of the Riley Park Cricket Club.

MR. HALL. Dr. Hirsch, I am a little mixed up on what your position is, but I know you know it and maybe I just did not glean it. But, I have high regard for you, and Matt Simmons recommended to the Chairman to ask you to come here. You seem to believe Peak Oil to be a valid theory, but you do not think the data of obtaining it is, I do not know if relevant is the word or important or necessary but only you stress the time it will take for viable alternatives to become available and we think we are underway. Maybe you can tell us if we are not, but we have pursued including alternative fuel vehicles and increased methanol production, hybrid cars, fuel cell driven automobiles, and a lot of other things and H.R. 6 is passed and been signed by the President. Maybe I am wrong, but it seems it depends on the assumptions you accept in making some determination on the Peak Oil problem. Is that a good statement?

MR. HIRSCH. This is very complicated and every bit helps and we should not think negatively about anything that can contribute particularly in the conservation area.

MR. HALL. I think Chairman Barton included all of them in H.R. 6 and I know you are familiar with that, but really thought we touched all the bases there.

MR. HIRSCH. But you were not considering Peak Oil when you put that bill together. If you dig into Peak Oil, it is probably going to be one of the most depressing subjects that any of you will ever have to think about or worry about because it takes not much time to think about what happens if there is less and less oil available and if the price of gasoline is $5 or $10, assuming that you can get it.

In the study that we did for the Department of Energy, we left the date of peaking out because there are so many different views. There are some people who think it will be very soon and there are other people like CERA that see it way off into the future. And you can find people that will pick almost any year that you want to choose to predict Peak Oil. What we did is to say we have got to fix the problem when it comes. What is it going to take to do that? And by looking at crash programs on everything that is commercially viable today, you are looking at the very fastest that human beings can do something. That is what we looked at. And what we found is that you need to get a head start on this 20 years before the problem starts. That is a long time.

Crash programs have not been done on a huge scale since the Second World War.

MR. HALL. But haven't the estimates or the guesses or whatever you call it, the projections that have been almost dosed with doom that symptoms come to our benefit and those projections were wrong? And Matt Simmons we talked about and Mr. Esser, I think you were aware of his book and knowledgeable about his book, seemed to say and I have heard him say ten years ago or five years ago that Saudi Arabia if we project what they had to start with and get to where we are now, they are out of oil and they are not out of oil.

MR. HIRSCH. They are never going to be--

MR. HALL. How do you handle that?

MR. HIRSCH. They are never going to be out of oil because a peak in production means that it is the maximum that you can have and then you go into decline. And decline depends on a whole lot of things like geology and history and management and a whole variety of things. So we are not about to run out of oil but if we do not have the oil we need that is demanded in the United States and the world, then we are in serious trouble.

MR. HALL. I sure agree with you. For example, on the good news that we can hope for in the peak study is--and I know you are aware of the Kern River was discovered in California, I believe here in 1899 and calculations in 1942 suggested that 54 million barrels remain, however, in 1942, after 43 years of depletion remaining reserve for 54 million barrels. That seems like that is good news to me for those of us who fear that we are peaking.

MS. HIRSH. The problem is not that there will not be a lot left after the world reaches peak production because there will. Peak will occur at something like for conventional oil, peak will occur at something like 50 to 55 percent of the recoverable reserves so there will be a lot of oil for a long period of time but there will not be the oil that we and the rest of the world needs as life blood for our economy and our civilization.

And the point, part of the point in all of this business, I kept saying think risk because in fact what we are doing is we are taking an enormous risk. I said I would love to agree with the optimists in this area and I asked the questions what are the risks? If the data is not there, solid data is not there, if the Saudis and others keep what they have as states secrets assuming they even know it, how--what kind of a risk are we taking because we are basically depending on them delivering to us in the future and if we are not ready when they get their maximum or when they decide to hold back, as I said which is in their national interest.

MR. HALL. I think I like what I am hearing but my time is almost up. Dr. Aleklett, I will get back to you a little bit later, but you have some

difference of opinion there that I would like to go into and the factors that you take into consideration for your projection.

At this time, I recognize Mr. Boucher, the ranking member.

MR. BOUCHER. Well thank you very much, Mr. Chairman. And I want to join with you in thanking our witnesses for spending time with us this morning and sharing their views on various aspects of the oil production peak globally.

Whenever we think that peak arrives, I think we all would agree that it is prudent now to start developing alternatives. And I would like to spend just a moment getting the benefit of your view about some of the obvious alternatives.

Mr. Esser, I was listening, I believe it was to your comments concerning a variety of alternatives to oil that are presently in the process of development or on the drawing boards. And you mentioned gas to liquids. I did not hear from your comments in reference of coal to liquids. And that impresses me as a particularly promising alternative. I know that South Africa for many years has been depending upon the production of liquids for transportation from coal primarily. We have in the United States 250 years of proven coal reserves. That is our predominate domestic energy resource. And I am told that the world oil price being approximately $35 per barrel, the conversion of coal into a liquid fuel is economic and of course oil is $20 above that today and likely to remain at elevated levels for some time to come. And so I would like to get the views of the panel members with respect to the potential for coal to be a viable source of liquid fuels. Where in the world is that technology being developed other than South Africa? Is it in place other places? What do you think the potential for coal to liquids is here in the United States?

I will express some skepticism about the viability of a large market for natural gas to liquids given the fact that we are experiencing a lot of pressure today with regard to having an adequate natural gas supply. Natural gas prices are estimated to be 48 percent greater this winter than the winter before. And about the only additional source of supply we forecast to be less is the importation of liquefied natural gas and with respect to that we have major problems in terms of a shortage of import terminals and a great deal of difficulty building those terminals for environmental reasons. So I am somewhat skeptical about the potential of natural gas to be a substantial source for liquid fuels. I would welcome some elaboration from you with regard to that.

Comment if you would on the potential for oil sands production from Canada. I understand that a substantial amount of investment is now being made by U.S. companies and others in that development, oil shale from Colorado and other places where oil shale is found, and also

comment if you would on the pace of the development of hydrogen fuel cells. We have a Federal initiative under funded in my opinion to develop transportation fuels based on hydrogen within approximately a 10-year time frame. Is that realistic? Where are we going to be ten years from now in terms of hydrogen replacing liquid fuels that are more traditional empowering transportation of this country.

So there are a number of subjects to address, Madam Chairman we will try to stay within our allotted time here in having the witnesses address them but do the best you can. Who wants to begin? Mr. Esser.

MR. ESSER. I will start with some of these. I do not have a lot to say about coal to liquids. In our longer term outlooks that is something that has more to do after 2020.

MR. BOUCHER. Well let me ask you this. Why is that? I mean if in fact it is commercial at $35 a barrel oil, why aren't we seeing development of that today?

MR. ESSER. I cannot tell you why companies have chosen to continue activity in other areas.

MR. BOUCHER. Have you studied this?

MR. ESSER. No, I have not.

MR. BOUCHER. That is not part of your analysis?

MR. ESSER. It is really not.

MR. BOUCHER. All right.

MR. ESSER. Regarding oil sands in Canada, I mentioned in my testimony that this is probably one of the highest intense oil plays going on in the world right now. Companies are struggling to get into the play, those that are not there, they are buying interests from other companies who are already there and involved, but are running short financially to be able to do this work. But there is no play in the world as exciting as this is right now. The companies that are there that have projects are intending to bring them on sooner at higher rates than they had originally considered and expansion projects in all of these individual projects are now being brought forward from the 2020 area to the 2015 area. So we see oil sands out to about 2020 of around 4 million barrels a day. This is up from 1.2 million barrels a day right now. In our longer term outlooks which we are actually working on right now out to 2030, we expect over 6 million barrels a day. This is from a huge resource of oil that is proven and we know that it is there. We have heard thoughts that it is very energy intensive in order to get the oil out. But you have to understand there is nothing more intense right now than company study and how to substitute for the use of natural gas in producing oil sands.

As far as gas to liquids, there are two huge gas fields in the world, the one in Qatar, the Northfield, and the one in Iran, which is the extension of the Qatar field into Iranian waters. Between these two fields there are

2,000 trillion cubic feet of gas. It is going to just take a lot to even make an impact on producing those reserves. This is the source for a lot of the LNG that we expect to import into the United States. And, of course, its going to go over to other countries too. The Iranian gas will not come to the U.S., but it will not only be used internally but be used for exports to adjacent countries.

Gas to liquids in general is related to what we call the industry stranded gas. There is really no use for this gas. It is far off. It is away from everything. We used to think Sakhalin Island, which is north of Japan, north into eastern Russia there was often no man's land. We have an LNG project there now and some of that gas is going to come to California in 2009. So stranded gas is a great source for gas to liquids. There are 200,000 or 300,000 barrels a day of projects on the books to develop in Qatar, but the problem is Qatar is becoming a development hotbed. There is just hardly room for any more activity along with all the LNG facilities that are being developed. But we see this as being a major source later on.

As far as oil shale is concerned, one company in particular has done some work on it. This is still very experimental. This is still something after 2020, but we do certainly have the resource here in the United States for that.

MR. BOUCHER. Well thank you, Mr. Esser. I would like to ask about hydrogen but I will defer that to you while we ask the other two gentlemen to comment on the basics of the question.

MR. HIRSCH. Let me talk about just hydrogen because I was on the academy's panel that reviewed a hydrogen program and provided the report that came out about a year ago now. We spent a year looking into the issues in a great deal of detail. It is technically feasible to do hydrogen, but it is not economically feasible. And for the economics to make any sense at all, you have to have breakthroughs in two areas in particular. One is in fuel cells which are totally inadequate for the application right now and the other is onboard storage. You cannot predict when those breakthroughs are going to occur. We took an optimistic view as to when these vehicles might enter the market in order to see how long it would take for them to have an impact. But do not bet on it. You just cannot bet on it because the things that are needed that are essential to go do not exist now.

MR. BOUCHER. Can we do coal to liquids and then return?

MR. HIRSCH. Coal to liquids is something that we included in our analysis. We feel strongly that it makes excellent sense. In fact, it can be done with essentially commercial technology now. I could go into that in detail, take some time if you wanted but I will not. So it is ready to go now. And in addition, the CO_2 that is produced when one converts

coal to liquids can be used for enhanced oil recovery so one gets a double plus out of that. And yes, based on the work that has been done at Mitertech in particular and elsewhere, the $35 to maybe $40 barrel number is a good number.

MR. BOUCHER. Okay. Mr. Aleklett?

MR. ALEKLETT. Well, the problem we are facing is that we are using too much oil per year, 30 billion barrels per year. You maybe do not remember, but you could take the east Texas oil field, that field is roughly 5 billion barrels. So if you look at the consumption globally, it is just a couple of months in the global consumption and that is a big problem. You do not find big fields. The largest field that was found during the last 20 years is in Kazakhstan, 10 billion barrels can support the world for four months. And we come into these things that should replace the oil if you take tar sand for instance, yes, it is a possibility they could push up the production to 3 million barrels if you do it in the crash program. But the problem with the tar sand is two ways. The tar sand is mining and mining if the technology is fine is working, but that is a small part of the tar sand. The big part you must get out with in situ and that means you must heat it up and take it out, and for that you need a lot of energy. And we are looking into a crash program for doing that and just now you must use nuclear power to heat up the tar sand to get it out.

MS. WILSON. [Presiding] Thank you. I appreciate that.

MR. ALEKLETT. Okay.

MS. WILSON. I appreciate that.

Mr. Sullivan from Oklahoma is recognized for questions for five minutes. Dr. Burgess?

MR. BURGESS. Thank you for having this hearing today.

This is probably almost more than I can understand. I am doing my best. Have you all worked with any of the national labs with any of the computer modeling since this is--you can't give us a date, you can tell us something bad is going to happen, the date keeps changing, the rules keep changing, you can't depend upon people to give you adequate information from other countries. Have you worked with any of the big simulation programs with the national labs to see if you can get any type of refinement on this or is this going to be one of those large nebulous worries that are out there like an asteroid hitting the earth and that sort of thing, that one day we will just run out of and there will be--

MR. HIRSCH. My work was for the Department of Energy, National Energy Technology Laboratory and I am familiar with the work at other laboratories. Computer simulations are not worth a damn if you do not have data to go in that has any kind of certainty to it. And that data does not exist. It simply does not exist. When CERA makes their estimates, they are using estimates. When other people predict other dates for

peaking, they are using estimates. They are taking bits and pieces of information, in some cases it is better. In some cases they are basing their projections on what somebody tells them without any independent verification. So a computer program with bad data is going to give you a bad result.

MR. BURGESS. Well the data is always going to be bad because the technology continues to change and any program that you wrote in 1998 would not count the impact of hybrid cars across the world. Any program that you wrote in 1995 was not--with the hydrogen initiative that has been started by the last Congress. But surely there is some concept of as the technology evolves this is the savings that we realize or this is the additional time that might be added to our time to peak line if there is in fact such a concept. Is anybody working on anything along those lines or again is this just one of those sky is falling scenarios that we are just going to have to live with and one day we will wake up and not have enough?

MR. HIRSCH. I ran exploration and production research at Atlantic Richfield and we looked at not only the technologies that were being developed, but we looked off into the future and there have been improvements, 3D, 4D seismic has come along, there is horizontal drilling that was developed in large part by somebody who was in the laboratory that I managed. There is deep water. What has happened there is rather dramatic and rather marvelous. But if you look at all of those things and the character of the problem, there will definitely be improvements made, but they are not going to change the basic picture. They will change the time by maybe a matter of years. Also, you have to keep in mind that some of those technologies in fact will drain reservoirs faster than would otherwise be the case. And under those conditions, you are going to have a big ramp up, but then you are going to have a much sharper drop afterwards. There is no simple answer to your question.

MR. BURGESS. Well the area where I live in North Texas you never would see a gas rig or an oil rig there when I was growing up. Now the place is littered with them because the technology has changed. You referenced horizontal drilling. I think in East Texas we perfected the slant well. There it was illegal but now we like the concept because we can drill under downtown Fort Worth and not disrupt the landscape. But again there has to be someone who is some futurist out there who is working on the types of technological changes that we might see and where we might capture additional capacity.

I would also suggest that at my hometown again they are working on a big bio diesel project to E85 ethanol vehicles and biodiesel and

biomass do these make any difference in the equation or are they too small to really figure into the numbers at this point?

MR. ALEKLETT. Well the problem with the technology that you put into Texas and to the lower 48 States, but if you look at reality, the production in the States are declining. And you have oil companies like Chevron for instance, they have many problems with technology that they bring in and they find more reserves and so on, but the production is declining. I think it has to do with the fact that it is much harder to get it out. So if you take Texas, East Texas field that you use all the technology you can think about, the decline rate in that field is just increasing. You are talking about 10 to 20 percent per in decline now. So what technology did was bring it out faster and we see now for instance in the North Sea that has had the technology in the sea from the beginning, the decline is now at 10 percent per year, 10 percent per year. So do not hope that technology will solve the problem. It might make the problem even worse in the future.

MR. BURGESS. Well if I may, what about the technology that is bringing fuels such as biodiesel--

MR. ALEKLETT. We are using as much as this and biodiesel might be the thickest of the line at the pump, you know. So again, we need to do it, but it is another kind of one that you are talking about. It is not in the same month or day that you compare it.

MR. BURGESS. Okay. Well I may be the only one here but it seems to me that we are willing to talk about problem that is soluble and we do not know when it is going to happen but is anyone offering, did I miss something because I came in late that someone has a solution that they are putting on the table or it is just simply we are going to again add to our basket of worries?

MR. ALEKLETT. Well I mean for United States, saving oil is the most important thing that you can do. I mean why should you consume twice as much oil per person than we do in Europe? I mean we are doing quite well with half the amount of oil. So that is the first thing you should look into and start to do something with. And I mean it is a great country.

MR. BURGESS. And my time is expired but the chairman did reference the Energy Bill that was passed this year that actually did have a balance between conservation and exploration. So I would submit that it is not that this committee is doing nothing in this regard and we appreciate you being here this morning but we have got to have more than just worries to lay here on. And again the basket of worries the American people have to deal with.

Madam Chairman, I will yield back.

MS. WILSON. Thank you.

MR. HIRSCH. Can I make a remark, just a brief one? Your question is certainly legitimate. I think that all of us would agree that you do not pick winners in a situation like this; you go with anything that is reasonable. I totally agree with my colleague here that biodiesel as wonderful as it sounds is going to be a sliver in terms of the problem. And finally, in terms of having a program, there needs to be a will first and there needs to be a worldwide will and then there needs to be Government stepping in and facilitating the private sector to doing things on a basis that has not been done before. That is the only way you are going to minimize the risks. That is not what we are talking about today in detail, but that is effectively what has to happen.

MS. WILSON. Thank you.

MR. BURGESS. I was going to say, I have a lot more faith in the private sector than in the Government. Again, I will yield back.

MS. WILSON. Thank you, Dr. Burgess.

Dr. Aleklett, you were talking about U.S. consumption of oil and a young friend of ours made a comment once on the difference between Europe and America that may help explain this and he said that he figured it out that in Europe 100 miles is a long way. In America, 100 years is a long time. My guess is that my grocery store and local school is a whole lot further from my house than yours is from your house. America is a different kind of place that way. And while we need to move forward with efforts towards energy independence and balance the energy policy and greater conservation, there are some differences between our continent and yours.

Mr. Allen from Maine is recognized for his questions.

MR. ALLEN. Thank you, Ms. Chairman.

And thank you all for being here.

I do have a different view here. I mean, I think that the great challenge we face is not a date. When King Hubbert made his predictions in the 1950's, he was regarded as a crank in the industry but he turned out to be right on the money in terms of when peak oil would occur in the United States. There are all sorts of people making projections today and most of them are going to be wrong either one side or the other but it is going to happen.

And I thought, Mr. Esser, just a quick question for you. It seems to me that the issue, I do not think many of you have talked explicitly much about price. We do lots of wishful thinking up here in this Congress these days but you have not talked so much about price. If it is an undulating plateau or a peak with a sharper decline, who cares? It seems to me the problem is that when the moment comes and I am not saying it is going to be one moment, it is going to happen, you know, relatively gradually over a period of years. It will be too late to take the kind of

action that we need to take today. That is the problem. And Mr. Esser, if you could talk a little bit about the undulating plateau, I read your remarks and you said our outlook shows no evidence of a peak in worldwide oil production before 2020 and you said, you know, maybe that is the earliest date you are willing to countenance but that is a scary date because in 15 years knowing the way this Congress operates, there is no possibility. We did not do a balanced Energy Bill in my--from my point if view. We need to act appropriately in relation to the risk not something that we may think is balanced but appropriately in relation to the risk. And the risk I think correct me if I am wrong is a dramatic rise in price that fundamentally changes our economy and makes the United States as the most dependent on oil at great risk in our competition and with other countries and that is what worries me.

MR. ESSER. It does that with the undulating plateau because once you are at this flat area and demand is still rising, that is your problem.

MR. ALLEN. So you did not mean for us to take comfort in the thought that it might be an undulating plateau--

MR. ESSER. That is right. It is certainly not. It is just that we do not see an isolated peak with a pretty sharp drop off after that. We put together our analysis by looking at existing production. We know the decline rates where we do it field by field because we have a production. We know what is being discovered. We know when it is coming on. We know the rate of exploration right now, what is being discovered, and when that could come on. So we feel pretty comfortable out ten years or so. But once we get beyond that, then you are guessing. First of all, what are going to be the new areas? Can the old ones stay up and we have mentioned about the fact that we do not have the data on many of the Middle East fields. And some time we are going to be surprised. In our outlook in Saudi Arabia, we never get over 14 million barrels a day because it is not safe to say that they could be the final producer and can supply anything to meet world demand. We know they are going to 12-1/2 by 2010. We feel that that is essentially in the bag but then after that we have to be careful.

MR. HIRSCH. If I could make one other comment, could I add something?

MR. ALLEN. Yes, please do.

MR. HIRSCH. Because another analysis very similar to what CERA did was done by the editor of Petroleum Review in the United Kingdom. And he used much the same projected data that you folks did, but he used different decline rates. And whereas they come to a conclusion that things are fine and in fact prices may drop before 2010, this other analysis using the same input data with a few differences comes up with a problem by then. And I do not know who is right and we will know

afterwards. Of course we will recognize that but it illustrates the difficulty in what goes into the assumptions and the lack of good data that we have.

MR. ALLEN. Would any of you care to comment on how the private sector is responding to this challenge? I am very worried about the American automobile industry for a whole lot of reasons. And the short--I would say if I were doing a critique of the auto industry here as opposed to the Japanese, I would say that our MBA's are looking about six months ahead at their financial results and the Japanese engineers are looking about ten years ahead as to what is going to happen in the world. And during the Clinton Administration there was a project, a public private partnership to develop hybrid vehicles. And when President Bush was elected, they moved away from it. They went--they just did not follow up on that. And now the Japanese are--have--you know it is one percent of the market or half a percent of the market today but this hybrid vehicle is going--hybrid vehicles are going to be a dramatic expansion of the market. I bought one in January of '03 because I was convinced that in the ten years I expected to own that vehicle, gasoline prices were going to go through the roof and I was not disappointed by that but I was disappointed in the fact that there was no American hybrid because the U.S. auto industry was so far behind in its future projection.

But just generally, can you say anything about where you think the private sector is responding well and where it is not to this particular challenge, Dr. Aleklett?

MR. ALEKLETT. I can do it for Sweden because I have been talking about this problem in Sweden for a couple of years. I know now that the Swedish companies in general have peak oil in their minds. I know that for instance Volvo has it. I know that Saab has it. I know that Sconia has it and it is on their agenda. And now the former director of Volvo in Sweden will be the vice president of Ford, so I know that Ford will have it also in their agenda now because he believes in these things, too. And I also know that some of the companies in Sweden will be on the forefront on this. And if you talk about the Japanese car makers, yes, they have been in Sweden and they have had consultants with us.

MR. ALLEN. Any other comments from either of you on how the private sector is responding to this challenge?

MR. ESSER. That has just changed the subject to natural gas. I would say 90 percent of the drilling right now in natural gas is what we call unconventional gas, tight sands, shale gas, and cosine methane. This is a different type of drilling and a different problem in completing wells. The success of it depends on flacking or opening up the reservoir by injecting water under pressure with sand in it in order to prop open the formation and let it flow. Gas related drilling has never been higher but

we cannot see being able to turn around the decline or the moderate decline we see right now in natural gas.

MR. ALLEN. In production in the U.S.?

MR. ESSER. In production in the U.S., and of course because of that, we are going to have to import a lot of gas starting now, but the big amount will not be here for a while. There are ways that the industry could respond more and bring on more gas within three years and that is access. We have blocks in the Gulf of Mexico that have been awarded for leasing, and block 181 which was up for initial leasing in December of 2001 and at the last moment only a sliver along the western side of it was allowed to be leased. So what did industry do? They found ten gas fields in this area that is going to come on production in 2008 at a billion cubit feet a day. The rest of the block you cannot lease, you cannot drill, it is just offsetting gas. If that were opened up, we could, in three years, have gas out of it. We have a trillion cubic foot field north of this called the Destin Dome. The companies had to give it up because they could not get it developed. So there are areas and things that could be done to bring on gas quickly. Again, Federal lands in the Rocky Mountains are some of the most predominant land owners there, but access to these lands is impeded at every step. So we could lower our decline so to speak in natural gas with access which we do not have, cannot get, nobody is interested in doing anything about.

MR. ALLEN. Thank you.

Mr. Chairman, my time has expired. I yield back.

MR. HALL. All right, we will authorize the gentleman who brought us here to question the witness if you would like. Mr. Bartlett, I recognize you at this time. First is there objection to these two gentlemen staying on the committee and questioning the witnesses? The chair hears none, let the record reflect.

MR. BARTLETT. Thank you very much for letting us ask some questions.

Let me go through some very hurried observations on what has been said and then ask you to comment on any of these that you wish. In 2000, there was a major paper by Energy Information Agency by an economist there who said that oil would never be more than $35 a barrel for the foreseeable future. I would just like to caution that what we are saying today could be as wrong as what he said there.

Ethanol production, you know, one should not look at the total BTU's in ethanol and assume that those are--will contribute to our energy usage. The production of ethanol I hope will be--have an energy profit ratio which is positive. It will never be very positive. We will always be putting a major percentage of the energy into producing ethanol that we

get out of ethanol. Just a word of caution in looking at ethanol and that goes for any of the things produced in agriculture by the way.

Two hundred and fifty years of coal, I wish we would stop saying that unless we qualified it by saying at present use rates because as soon as you increase use just 2 percent – we will be darn lucky if we can get by increasing it only 2 percent – at 2 percent it shrinks to 85 years. If you have to use some energy to convert it to a gas or a liquid to use it, you have now shrunk to 50 years. Yeah it is there, it is a finite resource. We really need to husband it but it is not 250 years.

Toyota and Mack Truck in looking at various scenarios for the future are asking what kind of truck will we be building in 2015 when oil is $200 a barrel. I understand that the Canadian oil sands are now producing oil at about $30 or less per barrel, really a good deal when it is selling for $60. I also understand that they may be using more energy from natural gas to produce the oil than they are getting out of the oil. That is fine if it is stranded gas but ultimately we will have a real limitation on what we can do there. They are now thinking of building a nuclear power plant there to get the quantities of energy that they use to do this. So I would just like to caution that the enormous reserves in the oil sands and tar shales are not net energy realizable. It is going--you know you may use six barrels of oil and get a net energy of one barrel of oil. I do not know what that energy profit ratio will be but it ain't high.

Fuel cells two problems with fuel cells, one is storage that was mentioned. We had experts testifying recently and they said of the three methods of storing it one is as a gas in a pressure vessel that is just too heavy. Another is a liquid. The insulation is too much and the difficulty of pressurizing it is too great. But the only feasible way that it will become economically widely used is to have solid state storage which really means you are dealing with a hydrogen battery. And a fundamental question is – is the hydrogen battery fundamentally more energy that is more energy efficient than an electron battery which we have a whole lot of.

I understand if you could wave a magic wand that every vehicle in the world today would have a fuel cell in it that we would use all the platinum for all the time and all of the world for as much generation of fuel cells that will now last 200 hours. So clearly, you have got to have some big breakthroughs in fuels cells before this is going to be feasible.

One of the ways of producing more oil is to drill as many wells in Saudi Arabia as we drilled in our country. We have about what three fourths of all the oil wells in the world in our country. Yeah, you will get more oil more quickly from Saudi fields but all you are doing is climbing a hill and the peak is going to be higher. You are going to fall off the peak and the descent, you know, you cannot pump what is not there and

if you are able to pump it more quickly now there is going to be less to pump in the future.

I would just like to note that there are risks that responding too early, you are using resources you might have used for something else but I think that the risk of responding too late are overwhelming, that any rational people would buy, you know, maybe responding too early. Thank God it is too early because if it is too late we are really in for a big problem.

The new technologies that are counted on to grossly increase production in the future, why haven't they increased production in our country? In spite of everything in our country, we are sliding down Hubbert's peak, we have been sliding down. There is nothing we have done that has really slowed, that slide down Hubbert's peak. Just look at the data, it is there. And I do not know why, we are a little microcosm of the world. I do not know why the world should be all that much different than I think we are.

I would like to caution about energy from agriculture. Two cautions, one, we are barely able to feed the world. Tonight, what, a fourth of the world will go to bed, a fifth of the world will go to bed hungry, something like that. And I would like to caution to be careful about how much biomass you want to rape from our topsoils. We are barely able now to maintain the quantity and quality of our topsoils and that is because we are returning humus to the topsoils. And I do not know, you know, I asked the Department of Agriculture, do you think we have more and better topsoil? The answer is no. For every bushel of corn we raise in Iowa, we lose three bushels of topsoil down the Mississippi River. So I would be very cautious about how much energy you expect--and by the way, it is not--the energy profit ratio from agriculture is not high. It is about one BTU--ten BTU's in for one out now. We would have to have a much more energy efficient agriculture if we are going to get any energy from agriculture in the future.

Twenty-five of the 48 oil producing countries in the world are now in decline. How are we going to get more oil in the future if that is true? And, you know, what to do? I think what we need to do is obvious, a massive effort of conservation, a big investment in efficiency, and big investments in alternatives. I do not think what we need to do is questionable. I think the will to do it may be very questionable.

Thank you, Mr. Chairman. I would like to ask for any comments you would like to make on these observations. Thank you.

MR. HALL. The gentleman answered his own questions pretty well as far as I am concerned.

MR. BARTLETT. But they may not agree with my conclusions.

MR. HALL. Well how many of you agree with him?

MR. ALEKLETT. Well most of the things he is correct.

MR. HALL. Give me about a one minute answer to his question if you can.

MR. ALEKLETT. We have now 65 countries in the world that are major producers of oil; 54 out of those 65 have already passed the peak of production and are going down. The next five years, another five countries will be past the peak, for instance China and Mexico that we know about. And so by 2010 there will be six countries that might be closer to increase their production. One of those is Bolivia and they are making something like 800,000. Yes, Saudi Arabia will go up to 12.5 and they are committed to do that, but Kuwait for instance, the big field there is declining now. They are officially saying that and many other things. So I do not think it is possible to get this increase. And just look at numbers and start to think for yourself because that is what we need now, even level thinking.

MR. HALL. Dr. Hirsch?

MR. HIRSCH. Well I would just amplify on his points. If you have got the overwhelming number of countries in the world that have been oil producers that are already past their peak, that means less production from them and world demand continues to increase, therefore, the gap is not just the increased gap, it is the increase plus the loss that is associated with these others on the down slope and that gets to be bigger, and bigger, and bigger, and the rates catch up to you very, very quickly.

MR. ESSER. I would just like to add that yes, a lot of countries are in decline, but there is some that are going to increase quite rapidly. I do not think the conversation has talked about unconventional liquids at all, especially gas related liquids. You just have no idea of the amount of condensate and natural gas liquids is a byproduct of all these gas wells that are going to supply all this LNG to the United States and other countries.

And Mr. Bartlett, you also talked about the application of new technology in the United States. New technology is allowed the deep water Gulf of Mexico to produce about 2 million barrels a day. Now without that technology we would be much worse off than we are now in the United States.

MR. BARTLETT. But we are still going downhill.

MR. ESSER. We are going downhill.

MR. BARTLETT. We are about half of what we produced in 1970.

MR. ESSER. I do not like to use these 50 percent rules because then you think you know what the total reserve is and in a lot of cases we do not and we get surprised. So the 50 percent rule can get you into trouble. But I think in the United States it is pretty safe to say we are well on the way down.

MR. HALL. All right, and we thank you very much. And is it fair to say of the 59 that you eluded to there, that you did not take into consideration the potential of the ultra depths?

MR. ALEKLETT. Yes, that is right.

MR. HALL. That is all I want to know.

MR. ALEKLETT. But take for instance Brazil that is considered to be one of the success nations. What they have found down there is something like 12 billion barrels of oil in ultra deep water. And 12 billion barrels when we are consuming 30 billion barrels per year, well can that save the world?

MR. HALL. I think we get right back down to it is the assumptions that we accept as to what the decision is going to be, but we are kind of like the pilot that all of his instruments have gone out. He did not know where they were going, or when they would get there, but just making good time. That is what I have gleaned from this, but it has been very good and I appreciate it.

We are going to recognize our colleague from New Mexico. I recognize you for your time.

MR. UDALL. Thank you, Mr. Chairman. And I think this has been a very productive hearing and we appreciate you doing this.

I think the crucial part of the debate here and you have--the panelists have hit it several times that it does not matter when we peak. The important thing and, you know we have people today that are reliable folks that are saying that we peaked already. And one of our panelists says it is 2030, others it could be 2010, we do not know. But I do not think we should be getting in that debate. The focus we should have on that is what are the things we should be doing at this time to move us forward. And clearly these panelists have hit on the idea of political will around the world and I think that is very, very important, us to have the will and the stamina to really take this on.

We have mentioned several things and I view these as really low hanging fruit and I would like your comments on them but are we doing the kind of research at the level that we could be doing the research compared to other sectors. And I am talking research in the energy area. My understanding we are doing a very small amount of research compared to what people do and Governments do in other areas. Another thing I am interested in that I would like to have your comment on is the price of gas and gasoline at the pump. I mean, we--I know this is a difficult thing but estimates, predictions, I mean what are we looking at in 2010, 2015, 2020? What as you get these production declines, I mean what are we looking at? And then if you also could comment, we face this issue of global warming which is a big one which the scientists tell us is, the science on that is getting stronger every day. How does that

intersect with what we are talking about here today, the use of fossil fuels and moving to alternatives and any of our panelists please jump in.

MR. ALEKLETT. Let me start with the global warming, please, because if you look into these scenarios about how much carbon dioxide that will be produced in the future, it is obvious that they are overestimating the amount that can be produced from oil and natural gas. And it is now more or less agreed that we can burn all the natural gas and the conventional oil and it will not affect so much the global change. The problem is coal. We should work on coal. We should not have the carbon dioxide coming out in the air from coal. That is a big problem for the future. And it is--yeah, I think I will leave it for the others for that.

MR. HIRSCH. I would like to comment on your point about political will because the political will in our system with the way things are working right now is very hard to muster. In fact, the current circumstances, the high probability would be to wait until the problem hits because then the political will will be there because the consumers will be screaming. I would say that in my testimony, China has the political will and China is out acquiring and investing in ways to secure their own supply. They seem to have the political will which we do not have as yet.

MR. UDALL. China is also are they not investing in these efficiencies in automobiles, I mean producing the--I know they are going to be putting many, many millions of automobiles on the road but they are also looking at efficiencies that are way above what we are achieving here in the United States isn't that correct?

MR. ALEKLETT. Another thing with China is that they can say that you are not allowed to buy a car that takes so much gas; you must buy one that takes a smaller amount. Another thing is we have the world problem with diesel coming out. Everyone thinks that diesel should be used because you get better efficiency on the cars. But the problem is that the capacity of producing diesel in the refineries is not enough in the world. And looking to China, they think they have their own solution for that, because they will use now natural gas for the trucks in China. They are preparing to build a filling station for natural gas for trucks and so on and in a couple of years, I think that will be running a big fraction of the trucks and so will natural gas. Another thing I think we have to consider is the countries in the Middle East and North Africa. These countries have 75 percent of the remaining resources of oil in the world and these people also understand that this is the only resource they have to make money for the future. And I have been down in the Middle East a couple of times now and every time when I am down there they said we had to think about future generations, our children and grandchildren; they must get money for something also. So why should we pump all now that we

do not need the money when our children need it in the future. And I could take one example of Kuwait. Whenever it comes up that they should increase their production, the parliament over there what they have, they say no. We should save it for future generations, so do not count on that these countries should increase their production, because they know that they need it in the future. I was in Berkley for several years and worked there and I liked to go up in the gold country and the ghost towns there were quite chilling. If you take Virginia City, if you have been there, you know the bars and restaurants were built at the end of the Nineteenth Century. That must have been glorious at that time. Today it is a ghost town and the reason is that there was a limited resource of gold that was there for a time and then it was gone. That is what my findings of the Middle East if these people are forced to pump oil much faster than they really need.

MR. UDALL. Mr. Esser, did you have any thoughts on that?

MR. ESSER. No.

MR. UDALL. Okay. Mr. Chairman, any predictions at all on prices in terms of gasoline? I mean are we going to go back down in terms of the price per barrel?

MR. HALL. Where are we on that?

MR. HIRSCH. I do not think anybody could tell you. And anybody that gives you a prediction may not understand the problem. It is too complex. There are too many forces at work. There are things that happen that are unpredictable. You cannot predict the price.

MR. ALEKLETT. I used to say that price offset in trades in London and New York and we get the price according to how much you are willing to pay for it.

MR. UDALL. Mr. Chairman, thank you for your courtesies.

MR. HALL. Why thank you. Dr. Aleklett, Dr. Hirsch, Mr. Esser, we thank you very much. To Mr. Bartlett and Mr. Udall, thank you for bringing this to our attention and to have requested this hearing and for your participation, the time you have prepared, the questions you have asked, and answers you have given. We thank you for it. You had to travel a long way. You had to be prepared over the last 15 or 20 or 30 years to be as intelligent as you are to come here and then you give us your time and we appreciate it. Thank you. Each member of this committee thanks you and each Member of Congress will read your testimony. They will have copies of it. So it is not just these few that you are testifying to, it is the Congress and anybody that really wants to see it anywhere. Thank you very much and with that we are adjourned.

[Whereupon, at 11:50 a.m., the subcommittee was adjourned.]

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