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ADVANCED ENERGY TECHNOLOGIES

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

TO

INVESTIGATE MARKET CONSTRAINTS ON LARGE INVESTMENTS IN ADVANCED ENERGY TECHNOLOGIES AND INVESTIGATE WAYS TO STIMULATE ADDITIONAL PRIVATE SECTOR INVESTMENT IN THE DEPLOYMENT OF THESE TECHNOLOGIES

MARCH 7, 2007

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ADVANCED ENERGY TECHNOLOGIES

WEDNESDAY, MARCH 7, 2007

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

The committee met, pursuant to notice, at 9:30 a.m., in room SD–366, Dirksen Senate Office Building, Hon. Jeff Bingaman, chairman, presiding.

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

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

Thank you all very much for being here. Today we're taking testimony on how we can stimulate investment and advance energy technologies.

The challenges we face in the energy arena are very substantial, as we all know. It's going to take a lot of combined effort and coordinated effort between government and industry and the investment community to make progress on this.

The problems of over-reliance on fuels from unstable or unappealing regimes and the looming problem of global warming lead to the conclusion that we need to find a new way forward on energy that reduces our reliance on foreign energy sources, and at the same time reduces the greenhouse gas intensity of our energy use. Whether you focus on the national security issue of energy independence or the environmental problems, obviously you wind up somewhat at the same place.

There are near-term technologies that appear to be very promising, such as electric and plug-in hybrid electric vehicles, using advance batteries, ultra efficient lighting and appliances, bio-fuels, renewable energy sources such as wind and solar generators, and near-zero emission coal plants with carbon capture and storage. These are all technologies that we believe can be commercialized, and in many cases, are being commercialized.

In addition to the use of these technologies, there's a great opportunity for us to establish U.S. leadership in the development of these technologies and the marketing of them. Other countries such as Japan, in the case of solar technology, and Denmark, in the case of wind power generation, have begun to stake out leads in commercializing technologies in these emerging markets.

There's no lack of innovation here in our own country, but we do need policies in place to ensure that we are a major participant in the development and commercialization of these technologies.

So we have a great group of witnesses today who are expert on these issues. We very much appreciate them being here. Before I introduce the witnesses, let me call on Senator Domenici for his opening comments, and then we'll introduce the witnesses.

I was told earlier there would be a vote or two votes at 10 o'clock. I'm now told that those have been put off. So we will just proceed after Senator Domenici's comments to the witnesses, and we'll go as long as we're able to.

Senator Domenici.

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

Senator DOMENICI. Thank you, Mr. Chairman. I have a statement for the record, so we can get on with it.

[The prepared statement of Senator Domenici follows:]

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

Let me begin by thanking our distinguished panel of witnesses for being with us today. All of you are involved in an important area for our nation's future—helping to make it possible for new energy technologies to make their way from the drawing board to the real world.

Our nation faces important challenges that we will need new energy technologies to address. Our reliance on imported oil and increasingly liquefied natural gas is a detriment to our national security. And concerns about the potential risks of climate change are driving us to promote innovative technologies that do not contribute greenhouse gases to the atmosphere.

I believe one of the most significant contributions of the Energy Policy Act of 2005 was authorizing the Secretary of Energy to issue loan guarantees for investments in innovative energy technologies.

I was pleased by the Department's announcement yesterday that it has received 143 pre-applications for loan guarantees. This is real evidence that there is significant private-sector interest in bringing cutting-edge technologies to market to re-invent our energy sector.

I continue to support DOE's efforts, and in fact I hope that the Department goes further to implement the loan guarantee program on the scale that was envisioned in the Energy Bill. In some cases, quick action on the loan guarantee process may make the difference between the United States gaining or losing the lead in commercializing new technologies.

I noted an example of this last week when we reviewed the EIA's annual energy outlook, but it bears repeating here. There is a company currently planning to build the world's first commercial cellulosic ethanol plant in Idaho, that has submitted a pre-application under the loan guarantee program. If the Department of Energy delays too long in its process of awarding loan guarantees, this potential capital investment in cellulosic ethanol will almost certainly be deployed elsewhere in the world first.

I also believe it is important to promote cleaner coal and advanced nuclear technologies. These are the bedrock of our power generation system. I noted that none of the witnesses discuss these technologies in their written testimony. I hope that we might have a discussion on financial incentives for nuclear and clean coal technologies at another time.

Ultimately, it is up to the private sector to build the systems that will ensure our access to clean, reliable, and affordable energy. But the government can, and should, partner with industry to encourage the development and deployment of new energy technologies. I look forward to hearing from today's witness how we can best accomplish this task.

Senator DOMENICI. It seems to me that nothing is more important than that we find ways to adequately finance the transition from the current economy to whatever the economy is going to look like after we have created innovations, innovations in the use of coal, other innovations.

A bill that we passed the year before last, had a title—title XVII, I didn't bring it with me—but I'll ask that it be made part of the record at this point as if it were here.*

Senator DOMENICI. Anybody that reads it and contemplates that paragraph would know that we did expect to give to the administration power for all kinds of financing mechanisms for innovative technology, in particular loan guarantees. We provided methods and manners for it.

We even provided a method for loan guarantees that was turned on its head by the people at OMB. They read it completely wrong. It was just intended to be a provision that said that we can have loan guarantees, and it won't cost the Federal Government anything, because the borrowers will pay the risk. There's a risk factor to be attached to the loans, and you'd pay that in advance, and it goes into a pool and that pool is there to save the government harm.

We've just been able to get that program started and it should be a very giant fund in my opinion. We're still pushing very hard, both the Chairman and I and many others, pushing the administration to do more, but I think eventually we're going to have to do more ourselves by being more specific in loan guarantee authority and loan guarantee mandates on the administration.

This need is across the board as we make the transition from nuclear fuels to wind technology, nuclear energy to wind technology, and I hope we can make some strides during the remainder of this year.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much. Our witnesses today are Dan Reicher, who's the director of energy and climate initiatives for Google, out of Mountain View, California; Elon Musk, who is the chairman of Tesla Motors from El Segundo, California; Jerome Peters, the senior vice president with TD Banknorth in Westport, Connecticut; John Denniston, who's a partner with Kleiner Perkins Caufield and Byers in Menlo Park, California; and Michael Liebreich who is with New Energy Finance. He's the co-founder and CEO on New Energy Finance out of London, England.

We very much appreciate all of you being here. Why don't we just go in the order in which you're seated, from left to right—our left to our right—and just take 6 or 8 minutes, if each of you would make the main points. Obviously, your full statements will be included in the official record of the committee hearing, but if you could make the main points that you think we need to understand, we would appreciate that. Dan, go right ahead.

STATEMENT OF DAN W. REICHER, DIRECTOR, CLIMATE CHANGE AND ENERGY INITIATIVES, GOOGLE, MOUNTAIN VIEW, CA

Mr. REICHER. Thank you, Mr. Chairman. Good morning to Senators Domenici and Thomas, and Senator Bunning. I'm very pleased to be here today, and pleased to talk about this very important topic of how we accelerate investment in clean energy technology.

*The information referred to has been retained in committee files.

I am at Google; have been there for the past 3 weeks. A year ago, Google set aside well in excess of a billion dollars to make major investments in climate and energy, global poverty and global health. I'm directing the climate and energy investment and policy unit at Google and we're intensely interested in this area of how you move clean energy projects and technologies to market. We want to be a big player in that.

I spent several years with a private equity firm, New Energy Capital, where we invested in several ethanol plants, bio-diesel plants, co-generation facilities and bio-mass power facilities. I also was with a major engineering procurement and construction firm that built major energy projects around the world, and for a number of years I was at the Department of Energy, where I was Assistant Secretary of Energy for Energy Efficiency and Renewable Energy.

To start, Mr. Chairman, I would note there is a very well-worn pathway for investment in clean energy. It starts, as you know, with high-risk, generally government-backed research to move technologies forward. It goes from there to venture capital and corporation-backed commercialization of that technology, and then it goes from there to actual deployment of the technologies—as we say, "steel in the ground," and that is the world of project finance and related financial mechanisms. Those are different steps along this pathway.

I think today's hearing is focused primarily on that final stage. The actual deployment of clean energy technologies at a scale that is significant enough to actually address our energy-related challenges, climate change, national security, poverty alleviation and economic competitiveness.

The good news, Mr. Chairman, is that there are an array of clean energy technologies that can be developed, that have been developed, with government and private sector investment, that can address many of these energy-related challenges. The not-so-good news is that investment, in the actual deployment of these technologies—again, "steel in the ground"—is lagging.

Sometimes the risk profile of the technology is too high. I think about cellulosic ethanol projects in this category. Sometimes the return profile of this technology is too low. I think about energy efficiency projects in this category. Sometimes the technology is too costly in comparison with competing technologies. I think about clean coal projects in this category.

The single most important point I'll make today, Mr. Chairman, is that aggressive Federal policy can drive private sector investment, measured in the trillions—trillions—of dollars that would be required to move the Nation and the globe toward a more sustainable energy future.

There are several very critical steps the Federal Government must take. First, the Federal Government must put a price on greenhouse gas emissions in order to internalize the cost of climate change and move energy investments toward lower carbon and more efficient technologies.

Second, we must remove barriers to cleaner and more efficient technologies and establish reliable, long-term incentives and rigorous standards to move these technologies to market.

Third, we must significantly increase public funding of research development and deployment of these technologies.

And fourth, the Federal Government must support fluid, transparent markets to monetize the environmental benefits that these technologies provide.

Let me highlight three technology areas where there are important lessons to be learned about the important role of Federal policy in stimulating private sector investments. First is the unprecedented level of investment in new corn ethanol projects in the United States which reflects, in large part, major Federal policy mechanisms adopted by the Congress: a renewable fuel standard, a blender's tax credit that's good through 2010, and a phaseout of MTBE.

In contrast, investment in cellulosic ethanol plants—which hold the prospect of a more sustainable approach to bio-fuel production—has lagged because of the higher risk associated with the projects and the weakness of the Federal Government's response—in particular, uncertainty surrounding the Federal appropriations for cellulosic ethanol projects and problematic Federal loan guarantees.

The second area I would highlight is wind projects. There is no better example of the role of Federal policy in stimulating and retarding investment in clean energy projects than the on-again, off-again, investment in U.S. wind projects, because of the on-again, off-again nature of the wind production tax credits. For more than a decade these credits have been here for a year or 2 and then gone for months or years. Investors simply will not back a U.S. wind project if it looks like the tax credit authorization will expire prior to completion of the project. This has caused a damaging boom-and-bust cycle in the industry. I would also note that largely because of IRS rules, the actual monetization of the tax credits is highly complex and expensive and there is a limited group of investors who actually qualify to use these credits.

The third technology area where there are policy lessons to be learned is energy efficiency. Mr. Chairman, energy efficiency is the real low-hanging fruit in the U.S. and global economy. From cars and homes to factories and offices, we know how to cost-effectively deliver a vast quantity of energy savings today, and the exciting fact is that this low-hanging fruit grows back.

The incandescent light bulb we replace today with a compact fluorescent, we will be able to replace again with an even more efficient bulb in the future. Similarly, we can take our gas-guzzling SUV today and replace it with a more efficient full-featured hybrid gas-electric model, and down the road we will replace the hybrid with an advanced model that runs on ethanol or bio-diesel and plugs into the electric grid.

However—and this is the important point—relatively little investment has found its way to commercializing or deploying energy efficiency technologies despite their cost effectiveness and reliability. Explanations range from the simple to the arcane. The less sexy nature of efficiency technologies, the often more disaggregated nature of their deployment, the greater challenge of financing savings versus production and weaker policy support.

In testimony last week that I gave before the Senate Finance Committee, I addressed how Federal policy can enhance private sector investment in energy efficiency. I highlighted an array of Federal policy instruments that can enhance investment, including automobile fuel economy standards, applying sufficiency standards, low income home weatherization investment partnerships, tax credits and research and development funding.

One policy mechanism that I want to end up with, and that I urge you to take a look at, is the Energy Efficiency Resource Standard, which could drive massive new investment in energy efficiency. The EERS, as it's called, sets efficiency resource targets for electricity and gas suppliers over the period of 2008 to 2020. It builds on policies that are now in place in a number of States across the United States, policies that have been quite successful, for example, in Texas and in Vermont.

The EERS is a compelling complement to a renewable portfolio standard. By moderating demand growth through an EERS and increasing clean generation through an RPS, we can slow and begin to decrease carbon emissions in the utility sector while we work to adopt more comprehensive climate change legislation.

In conclusion, Mr. Chairman and members of the committee, the investment community is ready, willing and able to back massive deployment of clean energy technology throughout this Nation and around the globe. However, without a major policy push by the Federal Government, that starts with long-term and reliable incentives and rigorous standards and includes putting a price on greenhouse gas emissions, we will simply not see the massive investment that our critical energy-related challenges require. The bully pulpit will not be enough to drive this critical investment. The Federal Government will indeed have to pay to play. Thank you very much.

[The prepared statement of Mr. Reicher follows:]

PREPARED STATEMENT OF DAN W. REICHER, DIRECTOR, CLIMATE CHANGE AND ENERGY INITIATIVES, GOOGLE, MOUNTAIN VIEW, CA

Mr. Chairman and members of the Committee, my name is Dan W. Reicher and I am pleased to testify today on federal policy measures that can enhance investment in clean energy, particularly energy efficiency. I recently joined Google where I serve as Director of Climate Change and Energy Initiatives for the company's new philanthropic venture called Google.org. Google.org has been capitalized with more than $1 billion of Google stock to make investments and advance policy in the areas of climate change and energy, global poverty and global health.

Prior to my position with Google, I was President and Co-Founder of New Energy Capital, a private equity firm funded by the California State Teachers Retirement System and Vantage Point Venture Partners to invest in clean energy projects. New Energy Capital has made equity investments and secured debt financing for ethanol and biodiesel projects, cogeneration facilities, and a biomass power plant. Prior to this position, I was Executive Vice President of Northern Power Systems, the nation's oldest renewable energy company. Northern Power has built almost one thousand energy projects around the world and also developed path-breaking energy technology.

From 1993 to 2001, I served in the Clinton Administration as Assistant Secretary of Energy for Energy Efficiency and Renewable Energy, Department of Energy Chief of Staff and Deputy Chief of Staff, and the Acting Assistant Secretary of Energy for Policy. Mr. Chairman, we have a broad array of options for addressing the nation's energy challenges, as other witnesses demonstrate in their testimony today. The federal government, through Congressional and Presidential leadership, has a powerful role to play in moving these energy solutions to market. I am honored to share with you my views as an investor, former policymaker and most importantly, as a

professional dedicated to ensuring our success in meeting today's energy-related challenges: climate change, national security, economic competitiveness and poverty alleviation. There are several steps the federal government must take to drive massive private sector investment—measured in the trillions of dollars—that will be required to move the nation toward a more sustainable energy future:

- First, the federal government must put a price on greenhouse gas emissions in order to internalize the costs of climate change and move energy investments toward lower carbon and more efficient technologies.
- Second, we must remove barriers to cleaner and more efficient technologies and establish incentives and standards to move these technologies to market.
- Third, we must significantly increase public funding of research, development and deployment of advanced energy technologies.
- And fourth, the federal government must support fluid, transparent markets to monetize the environmental benefits that these technologies provide. The market needs clear definitions of and ownership rules for renewable energy certificates, carbon offsets, white tags, and other environmental assets created by regulation at the federal and state level.

ENERGY EFFICIENCY—OUR CHEAPEST, CLEANEST AND FASTEST ENERGY OPTION

Today I have been asked to focus my attention on how to spur investment in what many see as our fastest, cheapest and cleanest opportunity to address our energy challenges—energy efficiency. Duke Energy CEO James Rogers has termed energy efficiency our "fifth fuel" and energy efficiency guru Amory Lovins measures it in "Negawatts". The federal government has the power to leverage vastly more private sector investment in energy efficiency thereby dramatically increasing U.S. competitiveness, improving our quality of life, and addressing climate change.

Energy efficiency is the real low-hanging fruit in the U.S. and global economy. From cars and homes to factories and offices, we know how to cost effectively deliver vast quantities of energy savings TODAY. And the exciting fact is that this low hanging fruit grows back. The incandescent light bulb we replace today with a compact fluorescent, we will be able to replace again with an even more efficient bulb in the future. Similarly, we can trade our gas-guzzling SUV today for a more efficient full-featured hybrid gas-electric model. And down the road we will replace the hybrid with an advanced model that runs on ethanol or biodiesel and plugs into the electric grid.

We have made an important transition in this country away from a focus on "energy conservation" and toward the more recent concept of "energy efficiency" (or "energy productivity"). In the era of energy conservation in the 1970's and 1980's we were asked to "do less with less"—to lower the thermostat, turn off the lights, don a sweater and leave the car in the garage. Energy efficiency takes a different approach, offering the opportunity to "do more with less". As McKinsey and Company states in a 2006 report, "By looking merely in terms of shrinking demand, we are in danger of denying opportunities to consumers—particularly those in developing economies who are an increasingly dominant force in global energy-demand growth. Rather than seeking to reduce end-user demand—and thus the level of comfort, convenience and economic welfare demanded by consumers—we should focus on using the benefits of energy most productively."

The main finding of the 2006 McKinsey report is that while energy demand will continue to grow, "there are sufficiently economically viable opportunities for energy-productivity improvements that could keep global energy-demand growth at less than 1 percent per annum—or less than half of the 2.2% average growth to 2020 anticipated in our basecase scenario." According to McKinsey, "Energy-productivity improvements can come either from reducing the energy inputs required to produce the same level of energy services, or from increasing the quality or quantity of economic outputs." The report concludes that globally the largest untapped potential for cost-effective energy productivity gains (>10% Internal Rate of Return) lies in the residential sector (e.g. better building shells and more efficient water heating and lighting), power generation sector (e.g. more efficient power plants and electricity distribution) and industrial sector (e.g. less energy-intensive oil refineries and steel plants).

However, McKinsey concludes that capturing this vast potential will require a significant policy push. McKinsey says, "market-distorting subsidies, information gaps, agency issues, and other market inefficiencies all work against energy productivity. Furthermore, the small share of energy costs for most businesses and consumers reduces end-use response to energy-price signals. Therefore shifting global energy demand from its current rapid growth trajectory will require the removal of existing

policy distortions; improving the transparency in the usage of energy; and the selective deployment of energy policies, such as standards."

As we consider this policy dimension we also need to consider how to harness an important and heartening new trend—the unprecedented flow of private capital toward clean energy. Who would have thought even a few years ago that Goldman Sachs, Citigroup, John Hancock Insurance, General Electric, Morgan Stanley, the Carlyle Group, Kleiner Perkins and other titans of Wall Street and Silicon Valley would be major investors in clean energy technologies and projects? In fact, in just the last year we have seen literally billions of dollars invested in companies commercializing advanced energy technologies and tens of billions of dollars invested in building clean energy projects. "CleanTech" has recently become the hottest new area of venture capital investing, while clean energy projects have become an important new element of the project finance world.

At the same time, most of this increasing investment in technologies and projects has been on the supply side involving key technologies like solar, wind, and biofuels. However, little investment has found its way to commercializing or deploying energy efficiency technologies despite their cost-effectiveness and reliability. Explanations for this range from the simple to the arcane: for example, the less "sexy" nature of efficiency technologies, the often more disaggregated nature of their deployment, the greater challenge of financing "savings" measured in Negawatts than production measured in Megawatts, and weaker policy support.

Regarding the last point, aggressive federal policy can make a major difference in the development and deployment of energy technology. In the case of ethanol, for example, Congress has enacted both a significant federal tax credit and major federal mandate which have helped stimulate massive new investment in production plants as well as new technologies. Energy efficiency has simply not enjoyed this kind of policy support and the investment that it generates. Below I address how federal policy can enhance private sector investment in energy efficiency, as it now supports critical investment in renewable energy.

I should emphasize that by moderating demand growth through energy efficiency, and at the same time increasing clean generation using renewable sources, we can slow and begin to decrease carbon emissions while we work to adopt and implement a comprehensive approach to addressing climate change. Congress should pay careful attention to this complementary strategy involving both energy efficiency and renewable energy as an important down payment on reducing carbon emissions, while it deliberates the more complex issues entailed in enacting and implementing an economy-wide climate policy.

FEDERAL POLICIES TO INCREASE INVESTMENT IN ENERGY EFFICIENCY

There are an array of federal policy instruments that can enhance investment in energy efficiency including standards, tax credits, and RD&D funding.

Automobile Fuel Efficiency

The single most effective energy efficiency policy ever adopted by the federal government is the Corporate Average Fuel Economy requirement (CAFE). Since its adoption in 1975, CAFE has cut U.S. oil consumption by over 1 billion barrels each year. Even with this progress, passenger vehicles today consume approximately 40% of the petroleum in the United States—with the transportation sector projected to generate 89 percent of the growth in petroleum demand through 2020. And the federal government has not significantly strengthened the CAFE standards in years, further diminishing their effectiveness. Raising fuel economy performance to 40 mpg over the next 10 years—through revision of the CAFE standards—could alone cut passenger vehicle oil demand by about one-third or 4 million barrels per day by 2020—about twice current daily imports from Saudi Arabia and Kuwait.

Existing technologies—hybrid electric automobiles, drive train improvements, lighter weight materials—can today get us to roughly double the mileage of our current passenger fleet. Perhaps the most exciting technological development has been the recent emergence of plug-in hybrids—a technology that will enable us to exceed any fuel economy proposals under consideration at this time. Plug-in hybrids have a more powerful battery than traditional hybrids and are designed to be connected to the electric grid for recharging. This allows the vehicle to cut gasoline use and, if charged at night, use lower cost and cleaner off-peak electricity. These cars can also benefit electric utilities when plugged in during the day by sending power back to the grid to meet peak power needs, thereby supplanting some of the most costly and often most polluting power generation. According to analysts, this benefit to utilities could be worth thousands of dollars per year per car, a value that could rapidly exceed the incremental cost of the vehicle's more powerful battery if shared with consumers.

By increasing vehicle use of electricity over liquid fuels, we should have an easier time improving the environmental profile of our automotive fleet. This is because lowering emissions from hundreds of power plants will likely be a more rapid and straight forward task than influencing the fuel purchases and driving behavior of millions of individuals. Even charged with electricity from coal dominated parts of our electric grid, a plug-in hybrid is generally cleaner than a gasoline powered car. In addition, plug-in hybrid vehicles enabled to run on biofuels can reduce greenhouse gasoline emissions up to 80%, and oil consumption by as much as two thirds.

The multiple benefits provided by plug-in hybrids call for significant federal actions to move this technology to market as quickly as possible. In addition to controls on greenhouse gas emissions and increased CAFE standards, the federal government can partner with the private sector to address outstanding technological barriers such as battery cost and performance. Even more importantly, the federal government should support deployment of plug-in hybrid vehicles through tax incentives and federal fleet procurement.

Energy Efficiency Resource Standard (EERS)

Just as the Senate has voted in favor of a Renewable Portfolio Standard, it should strongly consider a similar—and highly complementary—mechanism called the Energy Efficiency Resource Standard (EERS). The EERS sets efficiency resource targets for electricity and gas suppliers over the period of 2008-2020. It builds on policies now in place in eight states—California, Texas, Vermont, Connecticut, Nevada, Hawaii, Pennsylvania, and Colorado—designed to cut the growth in electricity demand through energy efficiency. The Texas and Vermont policies have been implemented for several years and have been very successful. Texas utilities, for example, are required to meet 10% of their load growth needs through efficiency programs. Utilities are easily exceeding this target, resulting in current consideration of raising the standard to as high as 50% of load growth. Vermont created an energy efficiency utility that has helped the state in recent years meet more than two thirds of load growth (typically 1.5 to 2% per year) through energy efficiency and the state is on a path to avoid all load growth in the near future.

Under the proposed federal EERS, suppliers are required to obtain energy savings from customer facilities and distributed generation installations in amounts equal to at least 0.75% of base year energy sales for electricity, and 0.50% for natural gas. This requirement is phased in over three years and cumulates during the compliance period. The requirement applies to retail suppliers, be they local distribution utilities or competitive energy suppliers, who sell annually at least 800,000 megawatt hours of electricity or 1 billion cubic feet of natural gas.

Eligible energy savings measures include efficiency improvements to new or existing customer facilities, distributed energy technologies including fuel cells and combined heat and power systems, and recycled energy from a variety of defined commercial and industrial energy applications. Savings are determined using evaluation protocols that can be defined by the Department of Energy (DOE), with state protocols available that the Department can build upon.

Suppliers may obtain and trade credits for energy savings under procedures to be defined by DOE. This will enable suppliers with energy savings beyond the requirements of the standard to sell them to suppliers unable to obtain sufficient savings from their customers within a given compliance period.

The EERS is a compelling complement to a Renewable Portfolio Standard (RPS), which the Senate has passed before and will consider again this year. EERS moderates demand growth so that RPS targets can actually reduce fossil fuel consumption. The RPS provision the Senate supported in 2005 calls for 10% of U.S. electricity generation to be generated from non-hydro renewable energy sources in 2020. However, the Energy Information Administration forecasts electricity demand to grow more than 22% by 2020. Unless we bring down demand growth, the RPS will not likely reduce fossil energy consumption or carbon emissions. The EERS proposal, as analyzed by the American Council for an Energy Efficient Economy would reduce 2020 peak electricity demand by about 10% or about 133,000 MW—equivalent to almost 450 power plants at 300 MW each. This would bring demand growth down to a level where a 10% RPS could meet all new electricity generation needs. ACEEE also estimates that by 2020, this provision will reduce natural gas needs by about 2 billion cubic feet, reduce CO_2 emissions by more than 340 million metric tonnes, and result in cumulative net savings to electricity and natural gas consumers of about $29 billion. Moving to a 15% or 20% RPS level, as proposed in recent bills, would further accelerate the move to a less carbon-intensive electricity system.

These two policies, EERS and RPS, figure prominently in a forthcoming report, prepared by the American Council for an Energy Efficient Economy and the Amer-

ican Council on Renewable Energy and supported by the Rockefeller Brothers Fund, that explores the synergies between energy efficiency and renewable energy. These two energy sources offer a highly complementary approach to managing the challenges of the U.S. power sector in the coming decades.

By moderating demand growth through an EERS and increasing clean generation through an RPS, we can slow and begin to decrease carbon emissions in the utility sector, while we work to adopt and implement a comprehensive cap-and-trade system. Congress should give strong consideration to this EERS-RPS approach as a straightforward down payment on reducing carbon emissions, while it deliberates the more complex issues entailed in enacting and implementing an economy-wide climate policy.

Utility Revenue Decoupling

The recent National Action Plan for Energy Efficiency (http://www.epa.gov/cleanrgy/actionplan/eeactionplan.htm) provides joint recommendations from federal agencies, states, the utility industry and environmental groups regarding energy efficiency. One area of focus in the report is the concept of "revenue decoupling". This approach, first instituted in California, decouples sales from profits, so that electric and gas utilities do not have a disincentive to promote energy efficiency. The current "throughput" incentive (the more electricity or gas a utility sells, the more it earns) is a significant impediment to energy efficiency. As state utility commissions work to advance decoupling, Congress and the Administration (especially FERC and DOE) should consider further incentives to promote energy efficiency. One important federal role would be to promote "best practices" and provide technical assistance to interested parties to facilitate energy efficiency.

Tax Credits for Efficient Buildings

Thanks in part to the efforts of this Committee, the Energy Policy Act of 2005 provided important tax incentives for efficient buildings and equipment, in addition to significant support for renewable energy and other advanced energy technologies. Legislation introduced last year by Senators Snowe and Feinstein, called the EXTEND Act, extends and expands these building-related incentives to enhance investment in energy efficiency. The principal purpose of the bill is to extend the temporary 2005 EPACT tax incentives for a sufficient length of time so that the business community can invest in complying with the significant requirements for the incentives.

Commercial buildings and large residential subdivisions have lead times for planning and construction of 2-4 years, so many businesses will refrain from making investments to qualify for tax incentives if the duration of the incentive is only 2 years.

The EXTEND Act provides four years of assured incentives for most situations, and some additional time for projects with particularly long lead times, such as commercial buildings. The EXTEND Act also makes an important modification to the 2005 EPACT incentives so as to phase out incentives based on the cost incurred in saving or producing energy and replace them with incentives based on the actual performance (measured by on-site ratings for whole buildings and factory ratings for products like air conditioners, furnaces, and water heaters.) The legislation provides a new home retrofit tax incentive for ambitious levels of energy savings that are verified by a third-party rater.

A goal of this bill is to provide a transition from the EPACT 2005 retrofit incentives, which are based partially on cost and partially on performance, to a new system that provides greater financial incentives based on performance. These larger incentives should not cost the Treasury more because the ambitious requirement of a minimum 20 percent savings will effectively eliminate free ridership, which is the problem that caused the current EPACT incentives to be scored as high as they were.

The Snowe-Feinstein bill also extends the applicability of the EPACT incentives so that the entire commercial and residential building sectors are covered. The current EPACT incentives for new homes are limited to owner-occupied properties or high rise buildings. The Snowe-Feinstein bill extends these provisions to rental property and offers incentives whether the owner is an individual taxpayer or a corporation. This extension does not increase costs significantly, but it does provide greater fairness and clearer market signals to builders and equipment manufacturers.

Public-Private Partnership on Low Income Weatherization

Across the nation, poor families often increasingly face the choice between heating and eating as prices for natural gas, heating oil, propane and electricity have skyrocketed and millions of poor Americans have found themselves spending more than

one-quarter of their income to run their furnaces, air conditioners and keep the lights on. In a survey of low income families—before the energy price spike in 2005-2006—32% went without medical or dental care, 24% failed to make a rent or mortgage payment, and 22% went without food for at least one day due to energy bills.

Congress continues to debate the traditional fix for this problem: additional funding for the Low Income Home Energy Assistance Program (LIHEAP). But we need to recognize the serious limitations of the roughly $2 billion we spend annually on federal fuel assistance, particularly as Congress considers the Fiscal Year 2008 budget. LIHEAP is essentially a one-shot buy-down of energy bills that covers only a modest percentage of eligible families—an absolutely critical but in no way sufficient answer to the energy woes of the poor. Together, federal and state fuel assistance funds provided less than 10% of the total energy costs for low income households in 2006.

The longer-term answer for the poor is home weatherization. By upgrading a home's furnace, sealing leaky ducts, fixing windows, and adding insulation we can cut energy bills by 20-40%—for years—and the substantial savings accrue with summer air conditioning as well as winter heating. And by adding energy efficient appliances and lighting the savings are even greater. Replacing a 1970's vintage refrigerator with a new energy efficient model will cut an average home electricity bill by 10-15%. Weatherizing low-income homes also improves comfort, reduces illness, and creates jobs.

Unfortunately, we have taken a penny-wise pound-foolish approach to low-income weatherization with less than $245 million in the 2006 Department of Energy weatherization budget, enough for only about 100,000 U.S. homes. And while the nation has weatherized about 5.5 million low-income homes since 1976, more than 28 million remain eligible. While the Bush Administration has supported increases in the weatherization program in the past, the 2008 budget proposes only $144 million, a cut of about $100 million that will have serious consequences for the nation's poor.

Instead of cutting weatherization funding, the President and Congress should make a national commitment to weatherize at least one million low-income homes each year for the next decade. This program would go a long way toward helping the most vulnerable among us—something the nation pledged it would do after Hurricane Katrina emphasized the extent of American poverty. The price tag for retrofitting 10 million low-income homes is relatively modest—about $2 billion annually when fully implemented.

With such a commitment there would be other benefits that directly address our current energy and environmental challenges. Stresses we are seeing today on the U.S. energy system—from blackouts to natural gas shortages—will be dampened with every additional home weatherized. For example, weatherizing all the low-income homes that heat with natural gas would cut residential U.S. use of this clean-burning fuel by about 5%, dampen its price volatility and reduce the call on federal fuel assistance funds.

The advanced technologies pioneered in the federal low income weatherization program can also be readily applied to the U.S. housing stock at large, with even greater energy savings. One technology developed in the Department of Energy weatherization program uses a pressurization device and a simple infrared sensor to pinpoint leaks down to the size of a nail hole for about $100 per home. With this information insulation can be installed in the right places with the least amount of waste.

As we cut energy demand we also cut air pollution. An Ohio study showed that weatherizing 12,000 homes not only cut the average consumer bill by several hundred dollars each year but overall avoided annual emissions of 100,000 pounds of sulfur dioxide as well as 24,000 tons of carbon dioxide—the primary global warming gas. As Congress and the Administration consider changes to the Clean Air Act and how to address climate change we ought to create an effective way to encourage power plant owners to invest in weatherization and other "downstream" pollution reduction opportunities. This could leverage substantial additional private sector capital for low-income weatherization and avoid the need for new power plants.

More broadly, we believe there are a variety of potential mechanisms to spur private sector investment in weatherization and we are currently exploring these within the financial community. One approach would:

- aggregate thousands of homes eligible for weatherization in a locality,
- establish a base-line of energy use as well as associated greenhouse gas and other emissions across the portfolio of homes,
- install advanced metering to monitor post-investment savings as well as provide utility load control,

- secure federal and state funding as well as carbon off-set, pollution credits, and utility capacity payments,
- leverage private sector investment in the aggregated portfolio through a "shared savings" approach or other financial mechanism,
- benchmark the investment to enhance replication.

There may also be an opportunity to provide an extra incentive or credit in the Energy Efficiency Resource Standard for investment by an electricity or gas supplier in low income home weatherization.

State Building Codes

California has demonstrated the significant efficiency gains that can be achieved through state building codes that are well designed and implemented. Title 24 of the California Code has been the national model, helping the state avoid thousands of Megawatts of new generation capacity. Despite this impressive track record in California, many states have inadequate state building codes or none at all. Section 128 of the 2005 Energy Policy Act authorizes $25 million per year for FY2006-FY2010 ($125 million total) for states that have adopted, and are implementing, both residential and commercial building energy-efficiency codes that meet or exceed specific standards. For states where there is no statewide code, the money will be allocated to local governments that have implemented codes that meet the above standards. Unfortunately, the funding authorized in the 2005 EPACT for state building codes was never appropriated by Congress and therefore this important incentive for adoption of state building codes has not been implemented. Congress should appropriate the funds authorized in the 2005 EPACT.

Appliance Efficiency Standards

One of America's least-heralded energy success stories involves federal appliance efficiency standards. In the last 15 years, Congress and the Department of Energy have set new standards for dozens of products. Refrigerators sold since 2001 in the U.S. use just one-third the energy of comparable models sold in 1980. Home air conditioners are nearly twice as efficient as those sold at the start of the Reagan administration.

Standards in place today will save American families and businesses about $200 billion cumulatively by 2020, cutting electricity demand and carbon emissions substantially. The 16 products in the Energy Policy Act of 2005 will save another $50 billion, and will cut carbon emissions by another 16 million tons in 2020.

Unfortunately, DOE has issued only two new appliance efficiency standards during the tenure of the current Administration. In the settlement of recent litigation brought by states and environmental groups, DOE agreed to issue 22 overdue standards in the next four years. Congress should ensure that DOE has the funds to conduct the necessary analysis, that the Department stays on schedule, and that it adopts rigorous final standards.

Section 124 of EPACT 2005 authorizes a new program to encourage deployment of high efficiency appliances, based on a successful New York program. The program, however, has not been funded. Congress should appropriate the authorized funds.

Federal RD&D Funding

Research and development is essential to supplying the "technology pipeline" we need to provide this century's clean energy solutions. Unfortunately, R&D on energy efficiency, as well as other energy technologies, has been falling. The Bush Administration's 2008 request for efficiency R&D is 18% below the FY 2006 levels, and more than a third lower than the 2002 budget. Total federal spending remains far below the peak of investment that occurred in the 1970s. And the private sector has not yet picked up the slack; efficiency funding in the electricity and gas industries has fallen even faster than federal investment. Some states, like California, Iowa, Wisconsin, and New York, are trying to pick up the slack, but their work is no substitute for federal support. Congress should ensure that adequate funds are appropriated in Fiscal Year 2008 and beyond to advance critical clean energy R&D.

Beyond R&D there are a number of deployment-oriented programs that Congress authorized in EPACT 2005 but has either not funded or has provided insufficient funds. These cut across many areas including buildings, appliances, energy codes, state energy programs, low income programs, public information and education, public buildings, and pilot projects. Also, the loan guarantee program authorized by Congress in EPACT 2005, which could be a significant help in energy efficiency projects, has yet to back any loans. All of these deployment programs help ensure that the technologies developed in the national laboratories or nurtured by federal R&D funding, actually get to the marketplace.

CONCLUSION

Mr. Chairman and members of the Committee I am confident that a concerted policy push by the federal government, as outlined above, can greatly increase private sector investment in energy efficiency, resulting in many benefits for the nation. I look forward to working with the Senate to develop, enact and implement legislation that will stimulate this much needed investment.

The CHAIRMAN. Thank you very much. Elon, go right ahead.

STATEMENT OF ELON MUSK, CHAIRMAN, TESLA MOTORS, EL SEGUNDO, CA

Mr. MUSK. Thank you, Mr. Chairman, members of the committee. The efforts of this committee really properly reflect our country's renewed emphasis on global climate change and on dependence of oil from nations that don't always have our best interest in mind.

I credit the committee with recognizing in the theme of today's hearing that the fundamental technologies required to address those challenges already exist in our national labs, universities, and private sectors at the base level.

The Tesla electric car is, I think, a clear example of technology that's here today that needs to be commercialized to the mass market. Let me talk a bit about Tesla's initial product, because this is a very good example that a lot of people are probably not aware of, of a working electric vehicle.

Tesla's initial product is called the Roadster. It's a high performance electric sports car, and as our unveiling of the Tesla Roadster has demonstrated, reports of the death of the electric car are greatly exaggerated. Moreover, the Roadster defies the conventions associated with electric vehicles, particularly with respect to performance.

My apologies for the brief commercial, but I think it's important to understand the key facts in order to appreciate what this car can do. It does 0 to 60 mph in 3.9 seconds. It has a 250-mile range, and that's an EPA highway range, that's not a figure we came up with by ourselves. It has a 135 mile-per-gallon equivalent, again calculated by the EPA. It costs $3 for a full charge, so less than a gallon of gas, of premium gas in California, about a penny a mile effectively. It's fully DOT compliant, crash tested, with air bags, crash structures, etc. and it has a price of $92,000.

So the Roadster is designed to beat a regular gasoline car, like a Ferrari or a Porsche in a head-to-head competition, but it has more than twice the energy efficiency of a Prius, the fully calculated energy efficiency of a Prius. So, in other words, it's a great car, without significant compromise.

Now some may question whether this really does any good for the world. Are we really in the need of another high-performance sports car? Will it really make a difference to global carbon emissions and our oil dependence? Well, the answers are no, and not much, however that's not the point.

Almost any new technology initially has a high unit cost before it can be optimized, and this is no less true for electric cars. The strategy of Tesla is to enter at the high end of the market where customers are prepared to pay a premium, and then drive down

market as fast as possible to higher unit volume and lower prices with each successive model.

We've seen this in, really, many industries. When cell phones first came out they were very expensive and then over time that technology cost got driven down. The same thing with laptops. Even things as mundane as airline tickets used to be very expensive, and now you can buy a round-trip ticket from L.A. to London for $400.

So, I should say Tesla's second model will be a large four-door family car, starting at $50,000 and the model that follows that will be an even more affordable family car, hopefully in the region of $30 to $35,000, again with similar statistics approaching a 250-mile range and that sort of thing.

In keeping with a prospering technology company, all free cash-flow is plowed back into R&D. We don't issue dividends; the management team doesn't get big bonuses, or any of that sort of thing. When someone buys a Roadster sports car they're actually helping to pay for development of a low-cost family car.

So the question becomes what public policy initiatives would be effective in accelerating the development of companies like Tesla Motors? What programs would inspire other companies to enter the arena? I believe that strategy boils down to three elements.

The most important area to which I would direct the committee's attention is the challenge of financing the mass market commercialization of new innovations and alternative technology. How do we really bring this to the American people, to the average consumer?

While the scale of various forms of equity investment in green technology has grown significantly in recent years, these sources of capital are expensive and volatile. Oil prices suddenly decline for a year and investment dries up, so what we really need is some form of debt financing that could be a very powerful catalyst for companies contemplating large scale production.

In the absence of government loan guarantees, or some other sources of credit surety, the cost of such debt is prohibitive. But a part of energy's loan guarantee program would, properly conceived and executed, provide an ideal vehicle for early- to mid-stage innovators to access necessary production capital at a reasonable rate of interest.

The delay of the loan guarantee program means that the tools for executing these programs are not yet in place at the Federal level. Our government has a number of departments and agencies, ranging from the Small Business Administration to the Department of Agriculture to Fannie Mae, that regularly engage in lending and other credit-related activities. I think we all agree that those do a very good job and serve an important purpose. To address America's pressing need for affordable, clean energy solutions, I urge you to provide maximum support for the DOE loan guarantee program.

As another means of accelerating innovation, I would counsel the committee to explore the use of competitions such as the X Prize. This is a no-lose proposition for the American taxpayer. Unlike cost-plus contracting where failure is often perversely rewarded with additional money, failure to win a prize costs nothing.

Offering prizes of meaningful size for achievements in alternative energy could pay substantial dividends. We've seen this be very successful in the Ansari X Prize, a prize for suborbital space transportation. It was also very effective in aviation with the Orteig Prize, which was won by Charles Lindbergh for crossing the Atlantic non-stop in a plane. It was very effective in figuring out how to determine longitude, the prize for ocean navigation.

In closing, I would direct the committee's attention to the need to incentivize consumer acceptance of alternate energy technologies. The rate of growth of these technologies is reliant in large part upon how soon they become affordable; incentives such as income tax credits for the purchases of new technologies of proven devices would spur the adoption of hybrid vehicles and solar installations.

I urge the committee to support the current effort to replace the recently expired electric vehicle tax credit with a meaningful tax credit that will catalyze the market for electric vehicles.

A tax credit is particularly necessary in the case of electric vehicles, because pricing, the normal economic mechanism that causes a shift in use, is broken in the case of oil consumption. I am not, myself, someone who's generally a big fan of tax credits, but I think in cases where the normal economic pricing mechanisms break down, as is the case here, I think we do need a tax credit. The price of gasoline would actually be far higher than what we see at the pump if it reflected the true cost of climate change and our Nation's vulnerability to the whims of oil exporting nations. Thank you.

[The prepared statement of Mr. Musk follows:]

PREPARED STATEMENT OF ELON MUSK, CHAIRMAN, TESLA MOTORS, EL SEGUNDO, CA

Mr. Chairman and Members of the Committee, thank you for inviting me to testify today on the subject of advancing the commercialization of advanced energy technologies. The efforts of this Committee properly reflect our country's renewed emphasis on addressing global climate change and dependence on oil from nations that do not always have our best interests in mind.

I credit the Committee with recognizing in the theme of today's hearing that the fundamental technologies required to address those challenges already exist in our national labs, universities and private sector. The Tesla electric car is stark evidence that the inventions necessary to develop viable alternatives to oil based automobiles are in place.

Tesla's initial product is a high-performance electric sports car called the Roadster, but the intent is to build electric cars of all kinds, including low-cost family vehicles. As our unveiling of the Tesla Roadster has demonstrated, reports of the death of the electric car have been greatly exaggerated. Moreover, the Roadster defies all conventions associated with environmentally friendly cars, particularly those of a purely electric nature. My apologies for the brief commercial, but to understand what is possible, I must present the key facts of the vehicle:

- 0 to 60 mph in 3.9 seconds,
- 250 mile EPA highway range,
- 135 mpg equivalent, per the conversion rate used by the EPA,
- $3 for a full charge,
- Fully DOT-compliant: crash tested, with airbags, crash structures, etc.,
- $92,000 price.

The Tesla Roadster is designed to beat a gasoline sports car like a Porsche or a Ferrari in a head-to-head showdown, but has more than twice the energy efficiency of a Prius. In other words, it is a great sports car without significant compromises. Now, some may question whether this really does any good for the world. Are we really in need of another high-performance sports car? Will it actually make a difference to global carbon emissions and our oil dependence?

Well, the answers are no and not much. However, that misses the point. Almost any new technology initially has high unit cost before it can be optimized, and this is no less true for electric cars. The strategy of Tesla is to enter at the high end of the market, where customers are prepared to pay a premium, and then drive down market as fast as possible to higher unit volume and lower prices with each successive model.

Tesla's second model will be a large four door family car starting at $50,000 and the third model will be a smaller, more affordable four door. In keeping with a fast-growing technology company, all free cash flow is plowed back into R&D to drive down the costs and bring the follow-on products to market as quickly as possible. When someone buys the Roadster sports car, they are actually helping pay for development of the low cost family car.

So the question becomes what public policy initiatives would be effective in accelerating the development of companies like Tesla Motors and what programs would inspire other actors to enter the arena. I believe that the strategy boils down to three simple elements: lower the cost of production capital, accelerate innovation and catalyze consumer acceptance.

The most important area to which I would direct the Committee's attention is the challenge of financing the mass market commercialization of new innovations in alternative technology. Specifically, how can companies like Tesla Motors accelerate the substantial investments in manufacturing and technology optimization that are necessary to bring electric vehicles to the average consumer? While the scale of various forms of equity investment in green technology has grown significantly in recent years, these sources of capital are expensive and volatile.

Debt financing would be a powerful catalyst for companies contemplating large scale production. However, in the absence of government loan guarantees or other sources of credit surety, the cost of such debt is prohibitive. The Department of Energy's Loan Guarantee Program would, properly conceived and executed, provide an ideal vehicle for early to mid stage innovators to access the necessary production capital at a reasonable rate of interest.

The delay of the Loan Guarantee Program means that the tools for executing these programs are not yet in place at the federal level. Our government has a number of departments and agencies, ranging from the Small Business Administration to the Department of Agriculture to Fannie Mae, that regularly engage in lending and other credit related activities. To address America's pressing need for affordable clean energy solutions, I urge you to provide maximum support for the DOE Loan Guarantee Program.

As another means of accelerating innovation, I would counsel the Committee to explore the use of competitions such as the X Prize. This is a no lose proposition for the American taxpayer. Unlike cost plus contracting, where failure is often perversely rewarded with more money, failure to win a prize costs nothing.

Offering prizes of meaningful size for achievements in alternative energy could pay substantial dividends. We are beginning to see how powerful this can be by observing the success of the Ansari X Prize, a prize for suborbital human transportation. It was a very effective use of money, as far more than the $10 million prize was spent by the dozens of teams that competed to win. At least as important, however, is the spirit and vigor it has injected into the space industry and the public at large.

Beyond space, as the Committee is no doubt aware, history is replete with examples of prizes spurring great achievements, such as the Orteig Prize, won by Charles Lindbergh for crossing the Atlantic nonstop by plane, and the Longitude prize for ocean navigation.

In closing, I would direct the Committee's attention to the need to incent consumer acceptance of the alternative energy technologies that are currently emerging. The rate of growth of these technologies is reliant in large part upon the degree to which these technologies become affordable.

Incentives such as income tax credits for the purchase of new technologies are proven devices for spurring the adoption of hybrid vehicles and solar installations. I urge the Members of the Committee and the Senate at large to support the current effort to replace the recently expired electric vehicle tax credit with a meaningful tax credit that will catalyze the market for electric vehicles.

A tax credit is particularly necessary in the case of electric vehicles, because pricing, the normal economic mechanism that causes a shift in use, is broken in the case of oil consumption. The price of gasoline would actually be far higher than what you see at the pump if it reflected the true cost of climate change and our nation's vulnerability to the whims of oil exporting nations.

Thank you for your time.

The CHAIRMAN. Thank you very much.
Mr. Peters, please go right ahead.

STATEMENT OF JEROME P. PETERS, JR., SENIOR VICE PRESIDENT, TD BANKNORTH N.A., WESTPORT, CT

Mr. PETERS. Thank you. I would like to thank the chairman and the members of the committee for inviting me here today to address the committee on matters which are vital to the development of policy that can provide this Nation with sustainable energy alternatives.

In order to properly address the issues surrounding the impediments to the deployment of advanced energy technologies, we must first identify the goals that we, as a Nation, expect to realize from these technologies. The commercial promise of any energy technology must be its ability to deliver cost effective benefits to the consumer without putting a significant burden on the Nation's taxpayers while lessening our dependence on foreign sources of energy.

Historically, governments have played a significant role in supporting the development of new energy technologies through the critical period between demonstration stage and the scale up commercialization. Over the last 25 years, U.S. policy intended to support and promote the development of new energy technologies has largely involved the availability of various tax subsidies to the owners of assets employing those technologies.

While this strategy has contributed to the deployment of a significant number of mature technologies by subsidizing energy production costs, tax subsidies alone have done little to promote the early deployment of emerging energy technologies. Since the passage of PURPA in 1978, Federal energy policy has supported the notion that renewable and efficient energy production must be cost-competitive with conventional sources. Since this Nation generates the vast majority of its energy from fossil fuel sources, continued cost competitiveness and thus, sustainability of advanced energy projects has been directly correlated to the volatility of fossil fuel prices.

History has demonstrated that energy projects which utilize advanced energy technology cost more than conventional energy projects; in many cases, 10 times as much. While efficiency gains and lowered or eliminated fuel costs offset a significant portion of the capital cost disadvantage inherent to these projects, the availability of tax subsidies alone do not permit such projects to be economically viable in certain low fossil fuel price environments.

The capital cost disadvantage combined with fuel price volatility present a risk environment that only a limited number of sophisticated investors are willing to enter. Project equity investors are generally bigger risk-takers and have yield requirements to match. Because of this, advanced energy projects funded with 100 percent equity will not be economic. Risk adverse lenders with significantly lower yield requirements can provide significant leverage. Debt lenders however, have little appetite for either energy price volatility or technology risk. While fuel price volatility can be mitigated through the execution of price-hedging strategies, technology risks cannot.

The Energy Policy Act of 2005 goes a long way in establishing a framework for the mitigation of technology risk for debt investors in advanced energy technologies; however, the subsequent issuance of DOE's August 2006 loan guidelines have dampened most, if not all, lender interest in participating in this program. While title XVII of the Act provides for loan guarantees up to 80 percent of total project cost, the DOE guidelines undercut that protection in two significant ways.

First, they limit the guarantee to 80 percent of the loan amount, shifting 20 percent of the technology risk to the lender, and seem to prohibit the substitution of additional equity to make up for the un-guaranteed portion of the debt. The addition of this technology risk component will significantly reduce the pool of lenders willing to participate in the program and will result in higher rates to the project developers.

Even more damaging to lender interests is the fact that the DOE guidelines require that any commercial debt brought into the project must be subordinate to the government guaranteed debt. The Superior Rights Provision of section 107(g) seems to prohibit the recovery of any unguaranteed portion of any commercial loan until the DOE's claim is paid in full.

Without collateral protection, the loan default and guaranteed call would most certainly result in a loan loss equal to 20 percent of that loan amount. While many lenders are willing to assume some level of loan loss risk, none, that I am aware of, are willing to take the first loss position in assets in which the collateral is pledged to the guarantor.

To summarize, I do believe that properly structured Federal loan guarantees can greatly assist in the accelerated deployment of advanced energy technologies. The USDA's business and industry guaranteed loan program comes to mind as a properly structured Federal guaranteed program that has contributed to the successful deployment of a large amount of current ethanol production.

There also may be other mechanisms, in addition to loan guarantees, that the Federal Government can facilitate in cooperation with technology providers and the investment community, that can overcome the current impediments to advance energy technology deployment.

Many of these mechanisms may well be technology-specific; for example, high capital costs may need to be overcome in certain technologies, such as cellulosic ethanol production and integrated coal gasification electric production, while uncertainty over long-term component light may be the impeding factor since the deployment of technologies such as fuel cells or concentrated photovoltaics.

I believe that a focused dialog among the various stakeholders, designed to create technology-specific, federally-backed enhancement programs would result in an accelerated deployment of advance energy technologies.

Properly structured, these enhancement programs need not put an undue burden on the Federal taxpayers or on the Nation's energy consumers. I, for one, would be happy to participate in these discussions. Thank you very much.

[The prepared statement of Mr. Peters follows:]

PREPARED STATEMENT OF JEROME P. PETERS, JR., SENIOR VICE PRESIDENT, TD BANKNORTH N.A., WESTPORT, CT

I would like to thank the Chairman and the members of the Committee for inviting me here today to address the Committee on matters which are vital to the development of policy that can provide this nation with sustainable energy alternatives. In order to properly address the issues surrounding the impediments to the deployment of advanced energy technologies, we must first identify the goals that we, as a nation, expect to realize from these technologies. The commercial promise of any advanced energy technology must be its ability to deliver cost effective benefits to the consumer without putting a significant burden on the nation's taxpayers while lessening our dependence on foreign sources of energy.

Historically governments have played a significant role in supporting the development of new energy technologies through the critical period between the demonstration stage and the scale up to commercialization stage. Over the last 25 years, U.S. policy intended to support and promote the development of new energy technologies has largely involved the availability of various tax subsidies to the owners of assets employing these technologies. While this strategy has contributed to the deployment of a significant number of mature technologies by subsidizing energy production costs, tax subsidies alone have done little to promote the early deployment of emerging energy technologies.

Since the passage of the PURPA in 1978, Federal energy policy has supported the notion that renewable and efficient energy production must be cost competitive with conventional sources. Since this nation generates the vast majority of its energy from fossil fuel sources, continued cost competitiveness, and thus sustainability, of advanced energy projects, has been directly correlated to the volatility of fossil fuel prices.

History has demonstrated that energy projects which utilize advanced energy technology cost more than conventional energy projects, in many cases 10x as much. While efficiency gains and lowered or eliminated fuel costs may offset a significant portion of the capital cost disadvantage inherent to these projects, the available Federal tax subsidies often do not permit such projects to be economically viable in certain low fossil fuel price environments.

The capital cost disadvantage combined with fuel price volatility, present a risk environment that only a limited number of sophisticated investors are willing to enter. Project equity investors are generally bigger risk takers and have yield requirements to match. Because of this, advanced energy projects funded with 100% equity will not be economic. Risk adverse debt lenders, with significantly lower yield requirements, can provide significant leverage. Debt lenders, however, have little appetite for either energy price volatility or technology risk. While fuel price volatility can be mitigated through the execution of price hedging strategies, technology risk cannot.

EPACT 2005 goes a long way in establishing a framework for the mitigation of technology risk for debt investors in advanced energy technologies, however, the subsequent issuance of DOE's August 2006 Loan Guarantee Guidelines has dampened most, if not all, lender interest in participating in this program. Title XVII provides for loan guarantees up to 80% of total Project Cost. The DOE Guidelines undercut that protection in two significant ways. First, they limit the guarantee to 80% of the loan amount shifting 20% of the technology risk to the lender and seem to prohibit the substitution of additional equity to make up for the un-guaranteed portion of the debt. The addition of this technology risk component will significantly reduce the pool of lenders willing to participate in the program and will result in higher rates to the project developers. Even more damaging to lender interests, is the fact that the DOE Guidelines require that any commercial debt brought into a project must be subordinate to the government guaranteed debt.

The "superior rights" provisions of Section 107(g) seem to prohibit the recovery of any un-guaranteed portion of any commercial loan until the DOE's claim is paid in full. Without "collateral protection", a loan default and guarantee call would most certainly result in a loan loss equal to 20% of the loan amount. While many lenders are willing to assume some level of loan loss risk, none, that I am aware of, are willing to take a first loss position in assets in which the collateral is pledged to the guarantor.

To summarize, I do believe that properly structured Federal Loan Guarantees can greatly assist in the accelerated deployment of advanced energy technologies. The USDA Business and Industry Guaranteed Loan Program comes to mind as properly structured Federal guarantee program that has contributed to the successful deployment of a large amount of current ethanol production.

There also may be other mechanisms, in addition to loan guarantees, that the Federal government can facilitate in cooperation with technology providers and the investment community that can overcome the current impediments to advanced energy technology deployment. Many of these mechanisms may well be technology specific. For example, high capital costs may need to be overcome in certain technologies such as cellulosic ethanol production and integrated coal gasification electric production, while uncertainty over long term component life may be the impeding factor to the deployment of technologies such as fuel cells or concentrated photovoltaics. I believe that a focused dialogue among the various stake holders, designed to create technology specific federally backed enhancement programs, would result in an accelerated deployment of advanced energy technologies. Properly structured, these enhancement programs need not put an undue burden on federal taxpayers or on the nation's energy consumers. I would be happy to participate in these discussions. Thank you.

The CHAIRMAN. Thank you very much.

Mr. Denniston.

STATEMENT OF JOHN DENNISTON, PARTNER, KLEINER PERKINS CAUFIELD & BYERS, MENLO PARK, CA

Mr. DENNISTON. Good morning, Chairman Bingaman, Ranking Member Domenici, members of the committee.

My name is John Denniston. I'm a partner with the venture capital firm, Kleiner Perkins Caufield & Byers in Silicon Valley. It's my honor to be before the committee this morning.

So, Silicon Valley has long been the fount of innovation and Kleiner Perkins has been there for a long time. It is one of America's oldest venture capital firms. We're a founder of TechNet, a network of technology entrepreneurs and CEO's and a member of the National Venture Capital Association. My testimony this morning reflects my own views.

Together with so much of the rest of America, venture capital professionals, both Republicans and Democrats, are concerned about the risks to our Nation's welfare stemming from our energy dilemma but we are also in a unique position to see how this enormous challenge presents new opportunities to build our economy, creating jobs and prosperity. Several years ago at Kleiner Perkins, we turned our attention to a new industry which we dubbed green-tech, which encompasses clean power, transportation and water.

You've asked me this morning to specifically address the current market constraints to greater green-tech investment and what kinds of policies might help unleash those sorts of technologies. Before I speak to that, I'd like to make one additional comment about how I and many members in the venture capital community perceive the energy challenges and opportunities in front of us.

I believe today that there's an unparalleled consensus in America on the three challenges that we face regarding energy: climate change, dependence on foreign oil, and the risk of losing our global competitive edge. But I am optimistic. The green-tech sector, in fact, is growing so rapidly it brings to mind for me a tenant of the information technology industry known as Moore's Law, and that's the idea that semiconductor performance will double every 24 months with no increase in price.

It's a remarkable phenomenon and this phenomenon almost single-handedly explains how we have been able to transition in a very short period of time from the era of huge mainframe centralized computers that only the largest corporations in America could

afford, to today, all of us can see the headlines in the news on our cell phones, a remarkable transition.

What I'm here to tell you this morning, Senators, is that a similar wave of innovation and accelerating performance is taking place right now in the clean energy field and could lead to solutions none of us can even imagine, faster than most can imagine. So your question is: what's holding back green technologies?

In my written remarks I describe several different sectors of our energy system and the specific constraints affecting green-tech investment in each, but since our time this morning is short, let me speak briefly about one of them: electricity generation.

Here's the biggest barrier I see in the generation market—green power costs more, relative to older, more established power sources. Why? Primarily because it's so new. Being new, it's at the very early stages of its inevitable cost reduction curve, and today it's being produced in such low volumes that the industry has yet to benefit from economies of scale.

On top of this, government policy today has provided powerful economic aid to fossil fuel and nuclear energy. Direct benefits over a period of decades include subsidies, tax advantages and R&D funds. Society, meanwhile, has also subsidized fossil fuel sources by bearing the costs of pollution including greenhouse gases.

In view of the urgent threats we face for our environment and to national security, public policy could and should at least level the playing field between the old incumbent sources and the new sources of energy. Indeed I would submit it should go one step further by driving the adoption of green technologies.

Thus, here are some recommendations for how Federal policy might help unleash green-tech power. You will see others in my written remarks.

First: adopt a market based national carbon cap-and-trade system which, if it sets an appropriate price on carbon emissions, will drive the adoption of green technologies.

Second: create a renewable portfolio standard that sets minimum levels of clean, renewable energy sources.

Third: strengthen Federal clean energy incentives, including tax credits, subsidies and yes, loan guarantees.

Fourth: ramp up research funding so it is commiserate with the scope of the challenges we face.

Fifth: make energy efficiency improvements a high national priority.

Sixth: lead by example, by making the Federal Government the No. 1 energy consumer and also the single largest consumer of green technologies.

Finally, seventh: follow through on President Bush's call for a 20 percent reduction in gasoline use over the next 10 years by expanding the renewable fuel standard and restructuring existing bio-fuel subsidies.

Once again I would like to thank the committee for inviting me here this morning. It has been a privilege. I believe we all have an opportunity to be part of the solution to our country's energy crises.

[The prepared statement of Mr. Denniston follows:]

PREPARED STATEMENT OF JOHN DENNISTON, PARTNER, KLEINER PERKINS CAUFIELD & BYERS, MENLO PARK, CA

INTRODUCTION

Good morning, Chairman Bingaman, Ranking Member Domenici and Members of the Committee. My name is John Denniston and I am a Partner at the venture capital firm Kleiner Perkins Caufield & Byers. It's my privilege to be here today and to have the opportunity to share my views on moving advanced energy technologies to the marketplace.

Ensuring a sound energy future is one of the most urgent policy challenges facing our nation and indeed the global community, and I sincerely appreciate this Committee's leadership in this arena.

Along with the rest of America, venture capital and technology industry professionals—Republicans and Democrats alike—are deeply concerned about the risks to our nation's welfare posed by our energy dilemma. Specifically, this includes the looming climate crisis, our oil addiction, and the very real danger of losing our global competitive edge. Yet our industry is also in a unique position to recognize that each challenge presents dramatic new opportunities to build our economy, creating jobs and prosperity.

Kleiner Perkins is a member of the National Venture Capital Association and a founding member of TechNet, a network of 200 CEOs of the nation's leading technology companies. I serve on TechNet's Green Technologies Task Force, which next week will release a detailed set of policy recommendations to drive the development and adoption of technologies we believe can help solve some of the world's most pressing energy and environmental problems. We refer to this emerging industry as "greentech," and for us, it includes clean power, transportation and water. We look forward to sharing that report with the Committee. My testimony today reflects my own views.

Based in California's Silicon Valley, and founded in 1972, Kleiner Perkins is one of America's oldest venture capital firms. We have funded more than 500 start-up companies over the years, backing entrepreneurs who have introduced innovative advances in such vital growth industries as information technology, medical products and services, and telecommunications. More than 170 of our companies have gone public, including Amazon.com, AOL, Compaq Computer, Electronic Arts, Genentech, Google, IDEC Pharmaceuticals, Intuit, Juniper Networks, Millenium Pharmaceuticals, Netscape, Sun Microsystems, Symantec, and VeriSign. Today, our portfolio companies collectively employ more than 275,000 workers, generate $90 billion in annual revenue, and contribute more than $400 billion of market capitalization to our public equity markets.

Before joining Kleiner Perkins, I was a Managing Director at Salomon Smith Barney, where I served as the head of Technology Investment Banking for the Western United States. Prior to that, I was a Partner at the law firm Brobeck, Phleger & Harrison, where I was the head of its Venture Capital Practice Group.

In the 1990's, I served on the Board of Directors of a California-based fuel cell start-up firm. That experience opened my eyes to both the daunting energy challenges our country faces and the myriad opportunities we have to solve our problems through technology innovation.

You've asked me specifically to address the current market constraints to greater greentech investment, and what kinds of policies might accelerate market adoption of alternative energy solutions. Before I speak to that, I'd like to take just a few minutes to offer an overview of how I and many of my venture capital colleagues perceive the energy challenges and opportunities facing our country today.

THE CHALLENGES

I believe there is an unprecedented degree of consensus in America today as to our three main energy challenges: the climate crisis, our dependence on oil, and the risk of losing our global competitive edge by failing to champion new technologies that are becoming a huge new source of economic growth, jobs and prosperity.

The Climate Crisis

Just last month, the most recent report of the more than 2,000 scientist members of the Intergovernmental Panel on Climate Change warned us, once again, that the planet is warming, glaciers are melting and sea levels are rising. The panel concluded, with ninety percent certainty, that most of this warming is due to higher greenhouse gas concentrations in the atmosphere, most of which result from human fossil fuel emissions.

Many scientists predict we have only a short period of time to make dramatic cuts in our greenhouse gas emissions or risk irrevocably changing the climate. In fact, the IPCC report concludes temperatures and sea levels would continue to rise even if we were somehow able to immediately stabilize atmospheric concentrations. To date, we have failed to heed such warnings.

I want to note that in the venture-capital profession, we never make commitments without thorough research and consideration. Professionally and personally, I'm convinced, on the basis of exhaustive scientific evidence, we need to take bold action to solve our climate crisis. But wherever you stand on this issue, it's clear a lot of creative momentum is building in this country to seek solutions to global warming, including new collaboration between energy companies, civic groups and scientists, such as the United States Climate Action Partnership (USCAP). This trend is promising not only for our environment, but for our national security and our economy.

Energy Security

As for our energy security dilemma, this Committee is well aware the U.S. imports about 30% of its overall energy needs, including approximately 60% of its oil. Rapid growth in worldwide energy demand has stretched supplies, tripling the price of both crude oil and natural gas. And there is a significant risk this trend will continue, as world population and energy demand increase.

Global Competitiveness

Finally, our future prosperity is at risk, and here I speak from very personal experience. Just in the past year, as I've traveled on business to China and Europe, I've witnessed how the rest of the world is striving, and often succeeding, to emulate the technology innovation that has been a hallmark of the U.S. economy and perhaps the single most important driver of our enviable standard of living. Increasingly, entrepreneurs overseas enjoy advantages in the form of determined government policies, including financial incentives and large investments in research and education.

Credible economic studies suggest our technology industries are responsible for roughly one-half of American GDP growth. Our country would look quite a bit different today had we not, several decades ago, become a global leader in biotechnology, computing, the Internet, medical devices, semiconductors, software and telecommunications.

Today, as our global energy challenges become ever more pressing, it's clear future economic growth throughout the world will depend to a great degree on new technologies to help us preserve our environment. Green energy technologies could very well become the economic engine of the 21st Century. Given its potentially massive market size, "greentech" could be the most powerful economic force of our lives. But will America again lead the way?

THE OPPORTUNITIES

Kleiner Perkins has been investing in the greentech field for the past seven years, backing more than 15 innovative companies in the fields of biofuels, coal gasification, energy efficiency, energy storage, fuel cells, solar energy, thermoelectrics and transportation. In the process, we've witnessed how technological progress is already revolutionizing our relationship with energy, solving problems that only recently seemed all but intractable. Solar manufacturers are innovating their way around silicon shortages, with next-generation materials including pioneering thin-film technologies. The agriculture industry is producing transportation fuels from plant matter—even from microscopic algae—and is developing technologies so we can economically convert non-edible plants to biofuels. And nanotechnology breakthroughs are creating the promise of new ways to store energy, which in turn could dramatically accelerate market adoption of solar and wind power.

At Kleiner Perkins, four accelerating trends have encouraged us to make greentech a core investment sector:

- The promise of exponential growth in the energy technology field. The rapid cost-reduction curve we are already witnessing will become ever steeper over time, making emerging sources of energy more and more competitive in the marketplace;
- Rising prices for fossil fuels—oil and natural gas—are making competing alternative energy sources more attractive;
- World class talent, with both missionary and monetary motives, is racing into the greentech sector;
- Americans are growing much more aware of and concerned by our energy crises, a development we believe will lend support to more sweeping policy solutions.

Moore's Law & The Pace of Technological Progress

In Silicon Valley, we often refer to a principle known as Moore's Law, which I'd like to explain briefly here, as it's fortunately quite relevant to what we see happening in the energy field. Intel co-founder Gordon Moore has been credited with predicting, back in the 1960s, that semiconductor performance would double every 24 months. That prediction was spot on, and helps explain the information technology revolution of the past three decades. Better, faster, and cheaper silicon chips led our transition from an era—remember, it was just 25 years ago!—of big, mainframe computers used principally by university researchers, to our capacity today to read the morning's headlines on our cell phones.

Today, we can already see a Moore's Law dynamic operating in the energy sector, giving us confidence the rate of greentech performance improvement and cost reduction will offer new energy solutions we can't even imagine right now. At Kleiner Perkins, we are excited by the technical breakthroughs we have seen in a host of scientific disciplines relating to the energy sectors, including material science, physics, electrical engineering, synthetic chemistry, and even biotechnology. We are particularly encouraged by innovations resulting from combining breakthroughs in several of these separate disciplines into single products.

Witness some of these examples of the greentech equivalent of Moore's Law:

- The price of wind power has plummeted by an order of magnitude since 1980, to the point where, in some regions, it is now very close to being able to compete with coal and gas power;
- Solar power costs have fallen by more than 60% over the past fifteen years;
- Ethanol production efficiencies per gallon have improved by more than 45% since 1982. Back then, state-of-the-art technologies produced a gallon of ethanol using 55,000 Btus with a capital cost of $2.25 per gallon of annual production capacity. Today, we can produce that same gallon of ethanol with nearly half the energy previously required, and at nearly half the cost.

These and other improvements have occurred over a period of time in which there was relatively little government policy or entrepreneurial focus on these sectors. Imagine what American ingenuity could accomplish in the future as more and more of our best and brightest devote their efforts to the greentech field.

But now I'll move on to speak specifically about my perspective on how government policy might encourage this emerging industry.

BARRIERS TO GREATER INVESTMENT AND MARKET ADOPTION: THE FIVE FACES OF THE ENERGY MARKET

The energy market is not monolithic. In fact, it comprises several distinct markets, each massive in scale and each with its own unique challenges and opportunities. These include energy generation, energy storage, transportation fuels, transportation, and energy efficiency.

Energy Generation

For the energy generation market, the high cost of new energy sources, relative to the incumbent competition, is the most serious barrier to greater capital investment and more rapid adoption of clean power. Why does green power cost more? Primarily because it's so new. Being new, it is still at the very early stages of its cost-reduction curve, and is presently being produced in such low volumes that the industry has yet to benefit from economies of scale. We can be certain American scientists and engineers will continually innovate to improve the performance and reduce the costs of these technologies going forward. But the speed at which they do so will depend to a large degree on government policy that is as bold and innovative as they are.

There's another way older power sources benefit from their longevity. Most coal-fired and natural-gas plants were constructed many years ago, and are now fully amortized. That means those facilities' owners no longer need to charge rate-payers for initial construction costs. Clean-power companies, in contrast, still need to include construction financing costs in their customer pricing, putting them at a major disadvantage.

On top of this, government policy to date has provided powerful advantages to fossil fuels and nuclear energy. In some cases, the federal government itself has paid directly for electrical generation facilities and transmission and distribution infrastructure. This pattern of favorable public policy goes back many years, and it made sense in its time. But times, as we all know, have changed.

Beyond government subsidies, the fossil fuel industry has long benefited by escaping responsibility for the costs of the environmental consequences of its emissions—

instead, society has paid the price. Clearly, traditional power sources would become much more expensive, and alternative sources of energy more cost-competitive, if plant owners had to take on the true costs of these emissions.

In the special case of nuclear power, the federal government has for many decades assumed enormous research and development, operating, waste disposal and containment costs, which if borne by nuclear plant operators would dramatically change the industry economics. As an example, private insurance companies are unwilling to insure nuclear power plants, which leaves the federal government as the insurer by default. The federal government has gone one step further with laws to specifically relieve nuclear plant operators of liability in case of accident. Further, the federal government has spent billions of dollars on nuclear waste disposal, and will need to continue to do so far into the future.

In view of the urgent threats we face to our environment and national security, public policy could, and should, level the playing field between old and emerging energy generation sources, and go further by driving the adoption of green technologies. There are indeed already several federal programs in place intended to encourage the adoption of renewable energy. Yet the incentives and benefits they provide pale in comparison to the advantages enjoyed by traditional energy sources, and have been inadequate in scope to meaningfully address the problems. In many cases, they are also of short duration, leading to a lack of predictability.

Energy Storage

Technical difficulty and the relative scarcity of investment opportunity are the two leading barriers to higher capital investment in the energy-storage sector. Energy storage has historically been a challenging technical field: essentially, scientists have to operate within the performance limitations provided by the periodic table of elements. Lead-acid batteries were first developed more than 150 years ago, and are still widely used.

Lithium-ion batteries alone have offered a significant jump in the amount of energy stored, yet still have safety and durability limitations. Until recently, we have seen only modest improvement in the performance characteristics of lithium-ion technology. It is important to note lithium-ion research and development has been dominated by Asian producers, leveraging off of their development of cells for consumer electronic applications. The number of U.S.-based electrochemistry experts is relatively small in comparison to U.S.-based expertise in other greentech fields, as a result of which there are not as many investment opportunities. Some of the investment opportunities in the field today involve basic research, whose particularly high risk makes it unattractive to most private investors.

Transportation Fuels

Private capital investment in the alternative fuels market increased significantly through the first three quarters of 2006, driven by excitement over ethanol's potential to address our oil dependence. However, these capital flows declined drastically in the fall of 2006, when in short order, crude oil prices plummeted from $78 per barrel to $49 per barrel, and corn prices skyrocketed from $2.50 per bushel to over $4 per bushel. The combination of higher feedstock costs and lower ethanol costs squeezed the profitability of the ethanol industry. As a result, the market capitalizations of public ethanol companies dropped dramatically, and these events had a similar ripple effect on private biofuels companies. I expect some of the publicly announced biofuels plants will not be completed on schedule, and others will not be completed at all.

In addition, gasoline has benefited from favorable public policy, including direct and indirect subsidies going back many decades, as well as from a free externality in the form of costly environmental emissions which are not reflected in the price of gasoline at the pump. The retail price of gasoline would increase meaningfully, and cleaner alternative fuels would become much more competitive, if the United States required gasoline to reflect the societal costs stemming from emissions.

Transportation

The market success of hybrid electric vehicles has produced heightened interest in high efficiency, low-cost vehicles. Most of the development work is taking place within the labs of major automobile companies. However, I expect several start-up automobile companies to introduce innovative vehicles in the coming years. Many hope the industry will be able eventually to produce commercially attractive plug-in electric vehicles in large volumes, although battery technology will need to improve considerably for that to become a reality, in my view. A relatively small percentage of automobiles sold in the United States today are flex fuel vehicles capable of being powered by gasoline or high blend ethanol ("E85"), in part because very few gas stations sell E85.

Energy Efficiency

In the case of buildings, we have today a range of available technologies for building systems and equipment, including improved lighting, windows, heating and cooling, and appliances. Collectively, these hold the promise of significantly improving building energy efficiency. Still other building-related innovations remain under development, including solid-state lighting, electrochromic windows, and solid-state refrigeration systems. However, the construction and building industries are among the most fragmented in the United States—no single company has the ability to drive efficiency into a meaningful portion of the market. In addition, many owners of existing buildings do not have the capital budgets to retrofit them to increase energy efficiency, even if the investment to do so is quickly recouped in the form of energy savings.

KEY POLICIES TO DRIVE DEPLOYMENT

Federal policy can do a great deal to help advance clean technology in all five of the energy markets. These are some of the policy initiatives I urge Congress to implement:

1. A Market-Based National Carbon Cap and Trade System.—A well-designed national cap-and-trade system could simultaneously address all three of America's energy-related crises: climate change, national security threats stemming from energy dependence, and the danger of losing American competitiveness. America had great success with such a system in the 1990s, when it was used to curb sulfur-dioxide emissions causing acid rain. The system would place a price on carbon, today a costly externality of our energy production and use, and reward companies for progress in adopting clean power. I urge Congress, in planning such a system, to assure that all credible green technology solutions have a shot at the market. It is impossible at this moment to predict which clean energy sources will have the most impressive Moore's Law-like properties in the future, and ultimately the lowest production costs. In addition, the cap and trade system should also include transportation fuels, as roughly 25% of U.S.-generated greenhouse gas emissions emanate from our transportation system.

2. Renewable Portfolio Standard.—A cap-and-trade system is no guarantee, by itself, of solving our carbon problem. Even if adopted and signed into law, it may not require deep enough reductions in carbon emissions to solve the problem, or it may well encounter other problems in its implementation. A national renewable portfolio standard would insure against such problems by establishing minimum adoption levels of clean and renewable energy sources.

3. Federal Incentives To Drive Clean Energy Development.—In my view, the federal government should dramatically expand financial incentives to drive the market adoption of green energy sources, with mechanisms including tax credits, subsidies, loan guarantees and other programs. Leading scientists tell us we need to have a national program of the urgency and scope of the Manhattan Project to stabilize our climate. Considering the added motivations of our national security threats and the U.S. competitiveness crisis, I believe such urgency and ambition is more than warranted. In addition, Congress should consider creating incentives for U.S. greentech companies to manufacture their products in this country. European and Asian countries offer incentives for U.S.-based companies to establish manufacturing operations overseas, in some cases including government payment of 40% of upfront capital costs and 15 year tax holidays. Loan guarantees may be an important part of this set of incentives, as long as they are structured to be attractive to lenders and to be available to both large and small projects.

4. Federal Research Funding.—Our urgent need to ramp up government assistance to clean energy sources certainly also applies to research and development monies. Total federal research funding for renewable energy (excluding nuclear power) and energy efficiency amounts to less than $2 billion per year. Energy consumption and transportation account for roughly 15% of U.S. gross domestic product, which is approximately the size of the U.S. health care system. But research and development funding for new and necessary technologies is not by any means commensurate. By comparison, the NIH budget this year is around $28 billion. To oversee our federal energy research funding, I suggest Congress consider creating a new agency—you might call it the National Institute of Energy—to consolidate and rationalize federal energy research funding.

5. Energy Efficiency.—The United States can make a significant dent in our energy challenges simply by making our energy system more efficient. Congress should strengthen CAFE standards, require energy efficiency standards for elec-

tronic equipment and appliances, and work with states to create energy efficiency standards for buildings. Congress should also evaluate how to work with utilities so their profit potential is driven as much by introducing energy efficiency as it is by selling power.

6. Federal Procurement.—The Federal government is the single largest U.S. energy consumer. As such, it can lead our energy transition by becoming the single largest green-technology user. Congress could establish a deadline for federal agencies to meet minimum clean energy use requirements. In addition, Congress could require all new federal vehicles to be hybrid electric, electric or flex fuel vehicles.

7. Biofuels.—Congress could take several steps to strengthen the rapidly emerging biofuels market. I recommend an increase in the Renewable Fuels Standard, consistent with President Bush's call to reduce gasoline consumption by 20 per cent over the next ten years. Another contribution would be to restructure the existing blender's credit so it is paid to ethanol producers rather than gasoline distributors, provides a credit level that is inversely related to the price of gasoline so as to create a safety net for ethanol producers in the case of a sudden drop in gasoline prices, and is made available to all alternative fuels, not just ethanol and specific molecular formulations of butanol. Finally, Congress should provide an additional subsidy for producers of biofuels from non-edible, and thus more sustainable, feedstocks; mandate flex fuel vehicles and E85 pumps; and create a fast-track approval process for energy crops.

8. Batteries.—Congress should define a program for the objective analysis of rechargeable batteries, possibly using one of the U.S. national labs. The battery industry has been plagued by wild claims, most of which are compilations of one-off "best-of" single values. The industry would benefit from a standardized, scientific-based testing program.

GOVERNMENT PROGRAM STRUCTURES

To my mind, two main structural issues significantly impede the effectiveness of existing federal policies and programs in driving new technologies.

First, to drive the necessary level of private sector investment in new energy technologies, we need stable, long term and predictable incentives. I believe these incentives should be in place for a minimum of five years, and, ideally, longer. Existing tax credits, including the Production Tax Credit and Investment Tax Credit, have experienced lapses and short-term extensions. For example, the Investment Tax Credit, created by the 2005 Energy Policy Act, was scheduled to expire at the end of 2007 and was only recently extended through the end of 2008. Such uncertainty limits the capacity of incentives to support projects with long lead times.

Second, federal policy should not attempt to pick winners and losers. Federal tax incentive programs today frequently deter innovation by specifying a limited set of eligible technologies. For example, the Investment Tax Credit sets a cap on fuel cells that limits the credit's value in driving fuel cell development. None of us can predict which of these various technologies will have the lowest production costs in the future. We need to open up incentive programs to a wide range of promising technologies.

Once again, I want to thank the Committee for inviting me here today. I believe we all have an opportunity to be part of the solution to our country's energy crises. I look forward to today's hearing and to learning about how we can work together to build a more secure future.

The CHAIRMAN. Thank you very much.

Mr. Liebreich, we're very glad to have you here. Thanks for coming.

STATEMENT OF MICHAEL LIEBREICH, CEO AND FOUNDER, NEW ENERGY FINANCE LTD, LONDON, ENGLAND

Mr. LIEBREICH. Thank you very much, Mr. Chairman. Thank you very much, Senator Domenici and the other Senators. I want to say how honored I am to be the only overseas representative here to give testimony today.

Just in case anybody's wondering why a Brit is here doing this, I will let you know a little about New Energy Finance. We are a research and information provider with about 50 people. All we do

is track renewable energy, biofuels, low carbon technologies and the carbon markets. We cover all stages of investment and we offer it globally, so we have offices in London, Washington, Shanghai, Beijing, Delhi, Perth, Tel Aviv and New York. So I hope to give a little bit of international perspective on the flows of financing and perhaps some figures to put in context the investment that is going on here today in the United States.

I've prepared some written remarks which you should have in front of you, and I'd like to refer to them as I go through. But rather than go into every point in detail, I want to draw your attention to some of the key points and some of the key statistics and research on investment flows.

So I want to start by saying that at this point in time there's no shortage of capital available for new energy ventures and for new energy projects, and this is what I refer to as the convenient truth. So if I direct your attention to the chart, in Figure 1* on page 2 of the testimony, there's investment overall globally in clean energy that has grown from $27.6 billion in 2004 to $70.9 billion. It's more than doubled over the past 2 years globally, and just to put that in perspective, the total investment globally in energy is somewhere in the order of $800 billion which means that around 9 percent of all energy investment currently today is already going into clean energy.

I won't go into the reasons for this rapid growth over the last 2 years. Senator Bingaman, in his introduction, touched on them and they've been much discussed, I think, already by this committee, but I would point out one of the results of this inflow of capital has also been a strong rise in valuations of new energy companies.

We track company valuations in the clean energy sector by means of an index, the NEX and you can see from Figure 3 in the written testimony, the NEX has outpaced the border market for the past 4 years. The increase in valuations have companies operating substantially in the clean energy space has been just over 30 percent per annum for the past 4 years. So that the overall global environment is a more than doubling of the amount of money flowing into the sector over the past 2 years. That's some indication of the sort of returns that are available to investors.

So let's turn to what's happening in the United States. In order to have a healthy clean energy industry you need to draw on different sorts of investors and Dan Reicher, in his testimony, referred to the difference between the technology investment side and the deployment investment. Indeed you need to kind of relay-race between different sorts of investors.

So we take the first leg of the relay, which is venture capital and private equity, it turns out that the United States' performance is actually extremely strong, contrary to what one might guess reading the press. In fact, the United States has a strong leadership position in investing in clean energy technologies.

Last year a total of $7.1 billion invested in venture capital and private equity in clean energy worldwide, of which $4.5 billion, just 63 percent, was here in the United States, so that's a very strong position. When you break it down even further and you start to

*Graphics have been retained in committee files.

look at the early stage technology investment, then the earlier the stage you get to, the stronger the U.S. position. So the United States actually out-invested Europe by a factor of something like 3-to-1 in early stage venture capital in 2005 and by 7-to-1 in 2006.

U.S. venture capitalists puts $390 million into American solar start-ups last year, and overall we know of no fewer than 627 funds in the United States that are either actively investing in clean energy technologies or looking to invest in clean energy technologies. We've got here on the panel, I think, some of the evidence of some of the people who've been so instrumental in building that leadership position and thanks to their efforts, the United States is among the leaders in some of the technologies that could eventually be revolutionary, such as thin film photo-voltaics and cellulosic ethanol, to name just a couple.

So that's the good news. The not-so-good news is that when these earlier stage companies need to look for more capital and they go to the public markets, the United States has not been the best place to do that. So under one-third, 28 percent of $10.3 billion raised by the public markets last year was in the United States and Europe has quite a substantial lead.

So you've got not a single pure play wind turbine manufacturer trading on a major U.S. stock exchange and you've got publicly-quoted Japanese, German, and Chinese companies that are clear leaders in silicone photo-voltaics as a result. There's a number of reasons for that weakness—one can hypothesize on many more—but certainly the high cost of regulation for going on to the U.S. public markets currently is one and also among the reasons is the perception that Europe is more committed to clean energy and is therefore a safer place to operate.

Project finance is now the deployment part of the picture, as these technologies are rolled out, wind farms built, bio-fuels, refineries built. There the United States was far behind, but has been catching up quite aggressively, adding 5.5 billion gallons of capacity total now and also adding 2.5 gigawatts of wind capacity last year. It has helped close the gap very substantially there, and so although the United States is still behind Europe, it has closed the gap substantially. But the fastest growing region is actually Asia.

Finally, I want to mention the carbon markets. I think a number of the panelists, my fellow panelists, have mentioned the need for a Federal mandated cap-and-trade system. I'll come onto that in a second, but just to give a feel for the amount of money: there is now no less than $11 billion in carbon funds worldwide. London is the leading location for the management of private carbon funds at 60 percent of the private money. The United States is not doing badly, particularly considering the fact that the United States did not ratify Kyoto and in fact, $1.8 billion is managed out of the United States of that $11.2 total, so that's a good sign of the fact that the United States will be a strong player in the carbon markets if and when on the State or Federal level joins in.

So we're not a policy think tank. I came here with a few ideas of policy areas that you might want to look at in order to increase these numbers and spur further investment. I think almost all of the five areas have been mentioned individually by others, but I will just list them.

First: there need to be some level of support. These technologies are more expensive. Clean technologies are more expensive currently and for the foreseeable future than dirty technologies. There needs to be a level of support but it needs to be stable and long-term support. The on-again, off-again nature of the current arrangements is very detrimental.

Second: there are cheap ways to reduce risk. It's often cheaper for taxpayers, for policymakers to work on reducing risk, rather than increasing returns and providing subsidies.

Third: accelerating, permitting, and time-to-market. There's nothing that our clients like less than projects that get delayed. It makes them feel like they're working in the wrong country, in the wrong region, on the wrong technologies.

Fourth: strong, long-term signal on energy efficiency. The United States can and should be a world leader on energy efficiency. The leadership is currently being displayed by Germany, by Denmark, Netherlands, and Japan. That should change and investors need a long-term signal to change their investment patterns.

And then, fifth and finally: a Federal carbon credit market. It needs to be one that establishes a cost of carbon that is sufficient to change investment decisions of the very large emitters.

Those are the five policy areas to be thinking about in our opinion. I'll finish this by thanking you once again for inviting me to come here to testify.

[The prepared statement of Mr. Liebreich follows:]

PREPARED STATEMENT OF MICHAEL LIEBREICH, CEO AND FOUNDER, NEW ENERGY FINANCE LTD, LONDON, ENGLAND

Good morning.

First, I want to say how honoured I am to have been invited to here today to share my thoughts on investment trends in renewable energy, low carbon technology and the carbon markets.

Some of you may be wondering what a Brit is doing discussing the U.S. clean energy market. So, I thought I'd take just a moment to tell you a little about New Energy Finance. We cover all sectors of renewable energy, as well as biofuels, energy efficiency, carbon capture and sequestration, hydrogen and fuel cells, and the carbon markets. We cover all stages of investment, and we are global, with 50 researchers in offices in London, Washington, Shanghai, Beijing, Delhi, Perth, Tel Aviv and New York. Our clients cover the spectrum of clean energy investors in a total of 26 countries.

I have prepared written remarks, which you should have in front of you. Rather than go into every point in detail, I would like to draw your attention to some of the key points. Along the way, I may refer to the charts, so if you have the testimony in front of you, feel free to follow along.

I'd like to start by saying that at this point in time, there is no shortage of capital available for new energy ventures and projects, either globally or in the U.S. This is what I call "the Convenient Truth". I would direct your attention to the chart in Figure 1 on page 2 of the testimony. It shows that investment in clean energy worldwide has more than doubled in the last three years, from $27.6 billion in 2004, to $70.9 billion in 2006.

To put these figures in context, total investment in energy worldwide is of the order of $800 billion, so around 9% of all investment in the world in energy today is already clean.

The reasons for this rapid growth in investment—concerns about climate change and energy security, high energy prices and so on—have been much discussed and I don't intend to go into them in detail here today.

One of the results of this inflow of capital has been a strong rise in valuations of new energy companies. We track these via a global index of publicly-traded clean energy stocks, which is published under the symbol NEX. You will see from Figure 3 that the NEX has outpaced the broader market in the last four years, recording a compound increase of 30.2% per annum for the past four years.

So that is the overall environment, globally, in terms of the volume of money flowing into the space, and the sorts of returns that are available.

Now let's turn to what is happening in the U.S. A healthy clean energy industry needs to be supported by a range of different investors. On the one hand, you need investors to support the development of technologies and equipment providers. On the other hand, you need other investors to fund the roll out of capacity-to-build wind farms, biofuels plants, etc. It's a kind of relay race.

In the first leg of that relay, venture capital and private equity (which have been such an engine of growth in this country), the U.S. is extremely strong. As you will see in Figure 4, in 2006 the U.S. dominated in this area, investing $4.5 bn out of the worldwide total of $7.1 bn. And when you break it down within that $7.1 bn, the earlier the stage of investment, the more the U.S. holds a dominant position. The U.S. out-invested Europe by a factor of nearly three to one in early stage venture capital in 2005, and by seven to one in 2006. Last year, U.S. venture capitalists put $390 m alone into American solar start ups.

My fellow panellists here with me today are all outstanding examples of the sort of people who have created this leadership position. Thanks to their efforts and others like them, the U.S. is among the leaders in a number of technologies that could eventually revolutionize the energy industry, including thin-film photovoltaics and cellulosic ethanol.

So that's the good news. The not-so-good news is that when these earlier-stage companies start to need more capital and look to the public markets, the U.S. has not been the best place to raise it. Note in Figure 6 that just 28% of the $10.3 bn in funds raised via the public markets in 2006 was in the U.S., with European stock markets taking the lead.

There is not a single "pure-play" wind turbine maker that trades today on a major U.S. stock exchange, despite the fact that wind is by far the most mature of the renewable energy technologies. Publicly-quoted Japanese, German, and Chinese companies are clear leaders in the production of materials used in silicon-based photovoltaic panels.

There are a number of reasons for this weakness, among them the high costs of regulation in the U.S. and the perception among investors that Europe is more committed to clean energy and is therefore a safer place to operate.

When it comes to project finance, the U.S. was far behind, but has aggressively begun to close the gap in the past two years. Last year, the nation's ethanol capacity more than doubled to approximately 5.5 bn gallons. A total of 2.5 GW of new wind projects were commissioned, bringing the installed base to 11.6 GW. As you will see on page four of my written evidence, the U.S. still trails Europe, but has made giant strides toward catching up, particularly in the last 18 months or so.

One final area I would like to mention is the carbon markets. As shown in Figure 9, no less than $11.2 bn has now been raised by investors looking to purchase and trade in carbon credits. A substantial proportion of this will be invested in clean energy projects in the developing world, under the terms of the Kyoto protocol. Despite the fact that the U.S. did not ratify this treaty, a total of $1.8 bn of these carbon funds are being managed here in the U.S.

London leads the world with 60% of all private carbon funds under management, but if and when carbon trading is rolled out in the U.S., whether on a state or federal basis, there is every sign that the U.S. financial sector will be a powerful player.

New Energy Finance is not a policy think-tank, so I have not come here with any specific policy suggestions. What I would like to do is highlight five themes the committee might consider as it seeks to craft policy to promote further investment in clean energy in the U.S. I do this very much with our clients' perspectives in mind: these are the areas they are telling us they would like to see addressed in order to make the sector a more attractive place to invest.

First, it's not just about subsidy and support. Clean energy is more expensive than dirty energy, so some level of support is needed. But when you do provide support, make sure it is long-term and stable. More than anything, investors want to know that the laws and regulations under which they created their original financial projections will remain the same for three, five, or even 10 years. A number of federal renewable energy policies provide subsidies which are, in some cases, generous but which periodically terminate. The recurring expiry of the wind Production Tax Credit, for instance, has pushed up the industry's cost of capital, causing bankers to incorporate "political risk" premiums into financing packages, and has kept turbine manufacturers from investing in the U.S. at the level required to create a domestic supply chain.

Second, look for ways to reduce risk. It is often cheaper for the taxpayer for policymakers to reduce risk than to provide subsidies. To produce adequate equity returns

even pilot projects must be partly debt-financed, but debt providers will not accept technology risk so there is a role for loan guarantees and for other sorts of pooled technology insurance mechanisms. Similarly, volatile prices for commodities cause investors to demand higher interest rates and equity returns. Government cannot (and should not) seek to eliminate commodity risk, but should design policy to shield this embryonic industry, perhaps via a mechanism under which support for biofuels projects is linked to corn and oil price spreads, so that in good years the subsidy falls away but in bad years cuts in.

Third, accelerate permitting and time-to-market. There is a strong correlation between the growth in clean energy capacity in any region and the speed with which permit applications are processed. Investors hate delays because they reduce returns and make them feel they are missing opportunities elsewhere. The U.S. should consider designating "clean energy zones" where developers know they will receive expedited consideration of wind, solar, geothermal, marine, mini-hydro, biomass, or other projects.

Fourth, lead the world in energy efficiency. This is an area where government must take the lead because consumers have shown they are generally not price-sensitive to energy costs and are thus rarely willing to make long-term investments to improve the energy efficiency of their homes or automobiles—even where such investments have positive pay back. There will be a huge economic prize for countries that lead—rather than lag—the trend. The U.S. can and should take the lead. Achieving improvements will take political leadership to change consumer attitudes, new regulations to insure compliance, and funding for new technologies. Investors need a strong signal of commitment in order to support the sector.

Fifth, establish a federal carbon credit market. To take serious aim at greenhouse gas emissions, a system needs to be put in place that seeks to raise the price of carbon to $40-$50 per tonne. All the research shows that this is the level needed to make new coal plants uneconomic and spur the closure of the oldest and least efficient plants.

Such a programme must be economy-wide, set long-term goals, and be locked in place for 20 years. And it has to be federal to prevent competition between the states to offer the most lenient emission terms.

With that, I'd like to once again thank the committee for this opportunity. I look forward to your questions.

The CHAIRMAN. Thank you, and thank you all for being here. I think this has been very useful testimony. Why don't we take 5 minute rounds of questions here, and maybe do a second round if people still have an interest in doing that?

Let me start with Elon. Let me ask you, and maybe Mr. Denniston or anybody else who wants to comment, Dan Reicher. This issue of energy storage and battery technology is one that I think is key to either plug-in hybrid or electric cars, or a variety of the clean energy opportunities that may be there in the future.

In your view, what are we doing and what should we be doing to try to get this technology developed and commercialized, the battery technology that's essential for us to realize the opportunities that you've discussed?

Mr. MUSK. That has actually been the primary area of research which has, of all the R&D money that we spent thus far, developed money, that's been the single biggest area. I think you've correctly highlighted what I think is the single biggest challenge in getting away from oil.

Gasoline happens to be an excellent energy storage mechanism and we need to have something which is competitive that is capable of storing electricity at a similar level of density too. We've been able to do that thus far, get 250 miles comparable to an electric, power to a gasoline car.

As far as what's needed, it's innovation needed at the cell level and at the pack level. Both are quite difficult. It's worth noting that currently, to the best of my knowledge, there is no mass-manufactured lithium-ion cell in the United States. I think it's actually

very important that that capability get developed, that there is some—there's R&D activity in the United States but there's not manufacturing activity of the cell.

Tesla does intend to manufacture its lithium-ion pack in the United States, long-term, but I think, very important to making that happen is something like the DOD loan program. I think that would be very effective because it is very capital-intensive, and as I'm sure you're aware, in places like Japan, the government is very supportive of such activity and helps make that happen.

Senator DOMENICI. What was that again?

Mr. MUSK. I beg your pardon, sir?

Senator DOMENICI. Your last comments, what were those again?

Mr. MUSK. I was just saying that the lithium-ion cell is it.

Senator DOMENICI. I got it. Thank you.

Mr. MUSK. Okay.

The CHAIRMAN. Mr. Denniston, did you have a comment on that?

Mr. DENNISTON. Yes, I do, Senator Bingaman.

So, energy storage has historically been technically a very challenging field and essentially scientists are limited, they're bounded by the periodic table of elements. Scientists can't invent a new element. They have to deal within the periodic table that you saw in your chemistry class in high school and so the lead acid battery, which is still used today in autos and in other applications, was invented over 150 years ago. The only significant innovation that has come since then is in lithium-ion batteries, which offer advantages but still have limitations in terms of safety. You've all read about recalls of lithium-ion batteries' durability as well, and in my opinion you're question is what we can do.

My answer is there needs to be more dollars going into basic research. I agree with Mr. Musk that the Asian manufacturers have led in research and development in energy storage, and my recommendation is that there be a research and development effort in energy storage in the United States.

A number of efforts are here today. They have difficulty finding funding because it's early-stage basic research, and this is where the government can be enormously helpful. I believe that the DOE's budget for energy storage is very, very, very small. I don't know the number exactly, but I believe it to be a very small effort.

I think you've asked an excellent question. Energy storage will help electric vehicles. It will help photovoltaics and wind power to become more valuable, lower their cost per kilowatt hour. Because when the sun is producing energy, if it's producing more than a house needs, then the homeowner can store that, but right now that's not economical.

The CHAIRMAN. Dan, did you have a comment on this?

Mr. REICHER. Yes, Mr. Chairman. I was just going to mention that there was the advance battery consortium, the ABC that Senator Domenici and others funded in the 1990's. I'm not sure what's happened to the ABC, but I suspect that funding which was pretty significant and did advance battery technology in the 1990's has in fact diminished. So I would encourage you to take a look again at that.

Second, I do think government procurement can drive this as well, as we've heard from a couple of our, my fellow panelists. The

government deciding to step up and whether it's a large buyer like the DOD and buy advanced storage technologies, battery technologies that can help as well.

And the last thing I think is, the other big storage technology is, of course, hydrogen. I think it's worthy of some debate about whether that's in fact, the place to be putting large amounts of money in storage these days.

The CHAIRMAN. Thank you very much. My time's up.

Senator Domenici.

Senator DOMENICI. Thank you very much, Mr. Chairman and let me say to all of the witnesses, I really thank you, thank you very much and appreciate your testimony, whether I agree with the whole testimony or not, I think your analysis for us of the need for money is in the right places.

I think what you are also saying is that it is strange that money can't go to the right places in large abundance right now, when there is such an obvious disparity between the price of crude oil and the cost of the new things that we're building. If it was back down to $25, or $20, we'd be wondering, but when you've got oil at higher than $50, it just seems like all kinds of money should flow into those alternatives that heretofore had a difficulty competing with that black stuff. I think you've told us it is, not like I would like or not how you would like, but it's flowing.

I, myself, want to put in the record the fact that the administration, it has been noted that the first cellulosic plant is proposed for Utah. Somebody wants to build it up there—Idaho—and has indicated to the Secretary that they would like to do that, and that they are looking for a loan guarantee and they will move with Canadian technology. That's not because of anything other than the fact that what they need to use for their basic fuel is in abundance in Idaho and not in Canada. It has nothing else to do with Canadian taste for research or the like, but that happened.

That would be interesting if in fact we could get the first one. It's the big major one and they would build it there. You agree we should move with cellulosic and ethanol too, do you not? I think somebody mentioned that in spite of all the other things we should do that also. Do you think we should do that too, Dan?

Mr. REICHER. Yes, absolutely and the good news, Mr. Chairman, is that in fact, the technology level, there is in fact, fairly significant money moving into a whole host of companies to develop various kinds of cellulosic technologies either biological or thermochemical.

The challenge right now though, as you're indicating, is actually getting real plants built.

Senator DOMENICI. Yes.

Mr. REICHER. We made a prediction in 1999 when I was at the Energy Department that in fact by 2007 or 2008, we would be producing more ethanol in this country from cellulosic sources than from corn. We were terribly wrong and part of that is that technology didn't develop as quickly as we expected. But much more importantly is that it has been extremely difficult to get real projects built for all the reasons that we've discussed already.

Senator DOMENICI. I also wanted to indicate—I didn't read my opening remarks—as evidence of the fact that there are plenty of

people looking for loan guarantees, the Department of Energy has announced yesterday that it has received 143 pre-applications for loan guarantees, and that's even without having the program that's worth very much. I mean the program is all, for many months was backward and had the wrong criteria. I think maybe it's getting there.

I do give the two head men at the Department—I don't talk to them without telling them this story first. If they say, "Hello, Pete," what I say is, "You're really messing up the portions of this bill on loan guarantees. Now we can talk. What are you going to do about it?" It looks like it's slow, might say fellow Senators, it is slow. That's caused by some people at OMB that do not like them.

Let me ask: you've spoken about a variety of things in the finance area that we need, but would loan guarantees work in the Department of Energy that were the kind we thought we ordered them to do? I don't know if you understand how it works, but essentially, you pay a premium for 80 percent and get 80 percent funding. You pay a premium. That premium is calculated on the basis of what Congressional Budget Office estimates for these kinds of loans, what the risk is on these kinds of loans. As a consequence the Federal Government doesn't lose any money. We don't get charged in our budget, so we thought we had a very good proposal which could have ended up with quite a few billions of dollars.

I wanted to ask, do you think that it would be helpful, if we got that in and it was a large portfolio maybe in the neighborhood of $3, $4, $5 or $10 billion? Could I ask Mr. Denniston, John, what do you think?

Mr. DENNISTON. Yes, Senator Domenici. I think that's a fabulous idea and yes it would be helpful; you've heard comments this morning on the need to build plants.

I would make two comments, Senator. The first is in the case of cellulosic, and we have invested in some of these projects so we have first-hand knowledge of this. There is a property at play for some of these technologies where they can work at relatively low volumes, and the physics and the thermal properties are relatively well characterized, and yet there's a risk as you scale a plant up, that those properties change, and so there's technical risk. We call it scale-up risk in a number of these projects, and so that's where the financing difficulty comes in. Yes, having a loan guarantee would be an excellent way to propel some of these plants that otherwise might not get built.

My second comment is as much as I am a fan of loan guarantees, and I am, I would respectfully submit that it's important to continually step back and ask ourselves what are the problems that we're trying to solve? I submitted three—climate change, oil dependence and global competitiveness—and really ask ourselves what the policy initiatives are that we ought to adopt, that move the needle most on those three core issues. Loan guarantees are a part of the puzzle, really important, but only part of the puzzle.

Senator DOMENICI. I understand that. If you read this Act you would see we did that.

Mr. REICHER. Mr. Chairman, I would just say quickly that they really work in the real world. In my last position with New Energy Capital, we got a loan guarantee for a bio-diesel plant in Delaware, the first large scale bio-diesel plant in the Northeast or Mid-Atlantic. We got it from the USDA.

There was some paperwork, but it allowed a regional bank, small regional bank that would otherwise have not made a loan, to make a loan for that plant and the plant is now up and running. So, it's pretty straightforward.

The CHAIRMAN. And is that at 80 percent of the cost of the plant or do you remember the percentage of the cost of the plant that was guaranteed?

Mr. REICHER. It was about 70 percent of the cost of the plant in that case.

The CHAIRMAN. Okay, all right. Senator Cantwell.

Senator CANTWELL. Thank you, Mr. Chairman. I was going to ask Mr. Denniston or anybody else who wants to answer this question. The investment in energy technology and other technology that you've invested in the past, I'm assuming it's a similar model, right, that VC's look at the investment. You don't expect everybody you invest in to be successful. Well, you hope they're all successful, but what is that model or that number that you're looking at?

Mr. DENNISTON. Yes, sure, great. It's a wonderful question. The venture capital business is a high-risk business. By definition we invest in early-stage projects that have technical risk, and sometimes that technology doesn't work out and sometimes there's market risk, where we think a product will succeed in the market. It's a novel product, a browser for the internet for example, and sometimes that works and sometimes it doesn't.

So, yes it's a hits business and in the venture capital industry at large. Some companies don't make it, they fail and that's an accepted part of the model.

Senator CANTWELL. What are we talking about like 1 in 13?

Mr. DENNISTON. Well, industry-wide you can see different estimates from 2 in 10 to 3 in 10—20 to 30 percent failure rates. Something in that range is probably an industry average measured over decades.

Senator CANTWELL. And so, and energy technology is following this similar model, is my question? Is it or is it not?

Mr. DENNISTON. I would say, Senator, it's too soon to say. Let me give you some numbers that will help, I think, put this in perspective for you.

The last year the venture capital industry in the United States invested about $2.5 billion in energy technologies. That's up from around $100 million, a mere $100 million, 5 years previously. So typically the cycle for venture capital portfolio companies to mature and go public is 3, 5, 6 years, and I would say it's too early in the cycle to know what the batting average will be for this cohort of green-tech companies.

Senator CANTWELL. But that shift that you just articulated is a huge shift in energy investment.

Mr. DENNISTON. Okay, so.

Senator CANTWELL. But I want to get to my point because my point is this. I didn't hear a lot about predictability per se and one

of my questions is, given that model that we're talking about and I know we're talking about R&D and loans and grants and things, but I'm more interested in predictability and a level playing field. So in that context, the tax credits and tax horizons that we were looking at have, up to this day, have been more near, you know, short-term, 2 to 3 years.

I'm assuming that if we're going to follow a similar model that's worked in other technologies' success, yes. VC's know they're going to choose well in some instances and not in another, but they want to understand issues over that horizon of the business. What are the likely other advantages that that technology investment might receive? So predictability from us in a longer horizon on tax credits, I would assume, would be an integral part of the strategy for investment.

I didn't hear a lot about that, maybe I missed it in the written testimony, but if people could comment on what you think the appropriate horizon is for these various tax incentives that we're considering, that would be great.

Mr. DENNISTON. I'll offer a point of view and then the other panelists, I'm sure, have a point of view.

So, Senator, I think you put your finger on a critical shortcoming with existing subsidies, which is—and a number of my fellow panelists have given examples of subsidies and tax measures that are year to year—and I would submit it is close to impossible for companies to gear up their business plans not knowing whether these incentives are there for the longer term.

In the case of wind, some of these projects take a couple of years to plan, get permitted and built, and if they have a 12-month expiration on the programs——

Senator CANTWELL. So because I only have 56 seconds left, what length of time are you thinking?

Mr. DENNISTON. I would suggest, and this is in my written remarks, no shorter than 5 years, hopefully much longer. Germany puts 20 years in.

Senator CANTWELL. And if you could in answering this, tell me also what you think the number is to actually get manufacturing of some of these facilities in the United States.

My first question was just about investment, for your business model what horizon do you need to see so that you have that component in looking at what you think the return is, but when I look at this equation, I see manufacturers of technology like wind technology.

They don't build wind turbines in the United States because they don't have the predictabilities and not only are we missing out on the ramp-up of wind, we're missing up on the ramp-up of manufacturing of wind. So what is the number for this, if it's 5 years for some predictability just on financing? What's the horizon that would actually get us job creation in the United States on this?

Mr. DENNISTON. I'll answer, and then I want other panelists to answer as well because you directed the question at me, Senator. Minimum 5 years.

I'm glad that you raised the point on manufacturing. You'll see that I addressed that in my written remarks as well. It is very im-

portant we try to hold manufacturing here in the United States through these kinds of incentives.

Senator CANTWELL. So how many years?

Mr. DENNISTON. I said minimum 5 years, hopefully longer.

Senator CANTWELL. Okay, all right.

Mr. REICHER. Senator, let me quickly draw an important distinction. There's venture investing which is in technologies, very high-risk, you know, put money up to lots of companies, only a few may succeed in a big way. That's simply to get the gadget ready to be used.

The bigger issue right now is project investing, much lower risk, the banks get involved and it's there where the amount of capital that's required is vast compared to the early technology investing, actually getting projects built. It's also there where the tax credits become so critical. The duration of the tax credits—a project developer needing to know that a tax credit is going to be available for multiple years in order to make the numbers work, to go to a bank to get this high level of debt that they can on the project, put in as little equity as possible to make the project work, so it's that world.

The venture world has a related but different set of issues and of course the venture world looks out ahead and says all right, I'm going to develop this gadget, can I ultimately get it deployed? What is the policy framework?

I just urge you to think that there are these two separate worlds with very different investments.

Senator CANTWELL. I understand your point, but then you answered my question, which is you need predictability.

Mr. REICHER. Long-term, stable, predictable support from the Federal Government.

The CHAIRMAN. Senator Thomas.

Senator THOMAS. Thank you, Mr. Chairman. The purpose of this meeting, as you know—and thank you all for being here—was to investigate ways to stimulate additional private sector investment into the deployment of technologies. You all have advocated and most of us do, for massive Federal subsidies.

How do we get private companies to unleash a little more into this? We all tend toward government intervention to cause it to happen.

How do we achieve advanced technology with the minimal amount of government intervention, other than spending taxpayers' money? I'd like each of you to comment on that.

Mr. MUSK. Actually, the point I wanted to make about the specific example of Tesla Motors. Tesla Motors receives actually no Federal support in any way either at the consumer level, at the company level, loans, any form whatsoever right now, and it's bringing a very competitive electric car to market starting manufacturing this year.

The issue is not one of whether the companies will succeed; I think they will. I think the amount of private funding will grow over time and will succeed even if there's ultimately no Federal intervention at all.

The question is whether we want to accelerate that pace or not, and I think we do need to accelerate that pace. The reason we need

to accelerate that pace is because as I mentioned in my testimony, the normal way in which the economy drives innovation in a particular area is by pricing, and unfortunately the gasoline price at the pump does not reflect the true cost of gasoline. Even though we may think it's a little high, it does not reflect the true cost of gasoline because the cost of the damage to the environment, the cost of oil dependence, global warming, is not priced in.

So we have a failure in the normal mechanisms of economics, which will result in a slower pace of transfer of private capital into that industry. That's why there is Federal intervention required, and ordinarily I would not be an advocate of Federal intervention.

Mr. DENNISTON. Senator Thomas.

Senator THOMAS. Yes.

Mr. DENNISTON. I think it's a fabulous question. I'd like to go back to the three problems I think we're trying to solve—climate change, oil dependence and our competitiveness—and I think echo a little bit of what Mr. Musk said. I'm a fan of the free market but it so happens in the case of those three problems, the free market is not set up to react to those issues.

So in the case of climate change: climate change is caused by greenhouse gases, which are a free externality. There's no way without government intervention that the market will recognize the real cost of those emissions and price it into the product, which in turn will reduce demand for the product. That will not happen in the free market.

In the case of oil dependence, the price of gasoline at the pump, $2.50, $3.00 doesn't reflect the fact that two-thirds of known oil reserves are in Middle Eastern countries and that percentage will go up to over 83 percent in the next 15 or 20 years. The free market will not recognize that risk. That's a risk that all of you are aware of. The market, the pricing mechanisms don't know, can't deal with that. That isn't what the free market does.

And finally with respect to global competitiveness, I can tell you because in the past year I've traveled to Asia, I've traveled to Europe and I can see what the governments there are doing. They recognize that the United States for a century has been dominant in technologies and our standard of living has benefited from that. They're on to this game. They are investing. Their public policy is aligned to succeeding and having them be a leader in technology innovation in these green technologies. So we're in a flat world, globally competitive, and my answer to your very good question is: I love the free market. I just don't know that these three issues are ones that the free market is well-suited to address.

Senator THOMAS. Anyone else want to comment on that?

Mr. LIEBREICH. Very quickly, if I can comment. I think that there is also—you can't get over the fact that the clean technologies are more expensive than the dirty technologies currently.

Wind power does cost more than power from coal or power from gas, so having decided that you think it's a good thing to have some, there is almost no way away from some sort of regulation or some sort of subsidy-based support. But that is only a very small part of the answer, because I think there are other ways you could make an area interesting for investors by reducing the risk and by accelerating the implementation of projects. So there are a number

of things that one can do on the policy front that don't require just pouring in more money.

I think in terms of risk you can look at whether it's the way that the production tax credit has been on-again, off-again. That has increased the cost of capital to developers of these projects. It has stopped turbine manufacturers from investing. There is no wind supply chain in the United States because you never know whether there's going to be a market or no market.

On bio-fuels, there's commodity risk which even if, as Senator Domenici pointed out, when the oil prices are $50, $60, everybody should be pouring money into the sector. Well, they don't, as much as they would, because they're concerned about what happens to oil prices in the future. There are ways of providing coliseum caps or insurance or reducing risk, that don't necessarily cost a lot of money and that are being experimented with in other countries, that can spur an enormous amount of investment.

Senator THOMAS. Thank you. I do have to say, however, that I think there is a public feeling about the future and there's a public feeling about global warming. There's a public feeling about where we're going to go with these kinds of things. So, there's more to it than just the economic side, I think. Thank you.

The CHAIRMAN. Senator Salazar.

Senator SALAZAR. Thank you very much, Senator Bingaman, and I know we're running really short on time here, so I would appreciate it if you would be willing to provide some written response to the question that I'm going to ask.

The question has to do with renewable portfolio standards and renewable fuel standards, and whether or not those are helpful in terms of incentivizing the investments from the private sector.

In Colorado, for example, we passed an RPS a few years ago that said that we would get the 10 percent of our energy production from renewable energy resources by 2015. Lots of investment has gone into Colorado. We are now upping the RPS in Colorado in legislation just passed a couple of days ago to 20 percent by the year 2015. So my question, I mean, we passed the RFS out of this committee just 2 years ago in the 2005 Act.

So my question is when we look at an RPS or we look at changing the RFS in this committee as part of our energy bill, what does that do in terms of the private market, looking at investments in these renewable energy areas? Maybe, John Denniston, why don't you take a quick answer to that, but I would really appreciate hearing from each of you in writing in the response to that question.

Mr. DENNISTON. I'll be brief to give time to my fellow panelists.

I think it would be an enormous signal, Senator, for the Senate to, for the Congress to adopt an RPS. Germany did this in a somewhat different way. They have a feed-in tariff system, but it really accomplishes the same purpose as an RPS, which is a minimum level of renewable use throughout the country.

That would be an enormous signal to the investment market and I think that single act would drive a lot of investment capital into this sector. It's an excellent idea and I urge the Senate to strongly consider that.

The renewable fuel standard goes to 7.5 billion gallons in the year 2012, and I would urge that to be increased in concert with President Bush's twenty and ten initiative. While I think the current RFS hasn't really impacted the market, because there's core demand because of MTD and pricing, I think if you significantly increase the RFS that similarly would drive demand and investment in the category.

Senator SALAZAR. Thank you very much.

The CHAIRMAN. Senator Bunning.

Senator BUNNING. Thank you, Mr. Chairman. I noticed in all of your testimony, not one of you mentioned coal-to-liquid fuel as a green technology that you are developing. Do you plan to pursue coal-based transportation fuels as an alternative to oil-based fuels? That's question No. 1.

I believe that coal-to-liquid fuels will dramatically be cleaner than conventional fuels. It's proven in South Africa. They're over 30 percent with that technology. The finished product is nearly zero in sulfur, low in NO_X emissions and low in particulate matters.

I know the real concern is carbon and carbon sequestration, and in the bill that I have put in, we sequester all the carbon. We are now doing a survey to find out how we can best serve by putting the carbon into either gasification and recycling it to the oil fields, or doing a survey in the United States and Canada right now on places to bury the carbon in the ground, the sequestration.

The question I ask: since we do not have a cap-and-trade system and China and India are not included in any of our emissions caps, in other words, to do that to the United States is fine. Let's get everyone else involved to do it, because we can get to zero in emissions. But I've been to Beijing and can't see. Every day, open my eyes and I can't see out, because of the unbelievable pollution that is going on there.

So, what I'm trying to say is that in 2005, we passed a bill. We're looking for help to go into 2007 now to refine that bill and most of you have said 5 years minimum. In the bill that I put in for coals-to-liquid, we put a 20-year because the Department of Defense asked for a 20-year cycle. They would be the biggest recipients and users of that type of fuels for not only aviation, but for their regular transportation system. So, anybody can pick up the ball.

Mr. PETERS. Well, first of all, Senator, I think that the coal-to-liquids technologies suffer from the same technology challenge that we have today, and that's scale-up. I think that loan guarantees are obviously something that are going to have to be required.

Senator BUNNING. But in the bill we require a 10,000 gallon scale in each of the first ten plants that we would invest in.

Mr. PETERS. Right.

Senator BUNNING. For the Government.

Mr. PETERS. But I think in addition to that, whereas with the V-tech legislation, we have a scaleable amount of credit that is available for cellulosic ethanol, for biodiesel, for corn-based ethanol. We're going to need something like that with the coal-to-liquids in order to be sure of the sustainability, long-term, of the product that you produce at the end of the day.

If we as investors, debt investors, are going to look at a product that 1 day is competitive with $60 oil or $70 oil and all of a sudden becomes uncompetitive with $30 oil, it's not a technology we're going to invest in.

Senator BUNNING. Well, we understand that, but for the security of the Nation, for the Department of Defense, if we can guarantee a certain price, like $40 a barrel and say put that as a floor in the bill. I can tell you right now, they're willing to buy and they have tested the coals to liquids, particularly aviation side, and they have burned in B–52's. They have a pilot program for that.

They also have a pilot program for on-ground vehicles for diesel, and they're testing that in a pilot program. They are ready to go if we can find the investors. Yes.

Mr. DENNISTON. Senator Bunning, my firm is an investor in a coal-to-liquid, a coal conversion company, and one perspective I'd offer to you is that coal can be converted to natural gas.

Senator BUNNING. Yes.

Mr. DENNISTON. Natural gas itself can be a transportation fuel. On my way here this morning, I saw many of your buses in Washington, DC are powered by natural gas. So it has the benefit of being both, coal to natural gas conversion, of being both a prime mover for electricity generation and a transportation fuel.

The company we invested in is Grade Point Energy, based in Massachusetts.

If I could add one more thing, the 5 years that I said before is absolute bedrock minimum.

Senator BUNNING. Minimum, I know.

Mr. DENNISTON. I think anything less than that is not worthwhile.

Senator BUNNING. No, you have to have stability.

Mr. DENNISTON. Germany went 20 years. I think they did that right.

Mr. REICHER. Yes, let me just follow up on that.

Senator BUNNING. Go ahead.

Mr. REICHER. When you look at support that the Federal Government has provided to energy generally in the traditional energy sources, there has tended to be very long-term support. I think about the oil depletion allowance, I think about nuclear liability insurance which is a minimum, I think, of 15 years.

So, I think that we have to adopt a mindset as we think about these newer technologies that not only is 5 the minimum, we should be thinking much longer term, with Federal support of the sort that the traditional technologies have enjoyed. I think if we level that playing field, we're going to be a lot further ahead as far as the investment community is concerned, with investment in technologies and investment in projects and investment in manufacturing facilities.

So, we ought to look at what we've already done in the traditional sphere as we think about the measure for these newer technologies.

Senator BUNNING. The only reason I brought up coal-to-liquids is we don't have to reinvent the wheel. It's already there.

Thank you very much, Mr. Chairman.

The CHAIRMAN. Senator Corker.

Senator CORKER. Yes, sir. Thanks again for great testimony. It's great to have people that are actually out there taking risk.

Talking about energy policy agenda, we actually are piloting one of your companies in Chattanooga, Eye on America. I know it's merged with another entity now, but we're actually producing through a hydrogen fuel cell, power into the power grid. I hope that that's commercially viable and hope we make those in Tennessee when it is.

As it relates to the macro public market issue, we hear a lot here in our country, obviously, about bio-fuels, and there's a lot of interest in that. I just had a long briefing this morning, but from the standpoint of investment that's taking place worldwide, obviously real money, smart money usually is going after those most promising technologies. I know that some of the bio-fuels are actually more mature and would be beyond venture capital funding at this point, but what are you seeing on the public markets as it relates to bio-fuels and their relevance? Or is most of the technology investment in harder type technologies? Either one of you.

Mr. LIEBREICH. I'll start off and then pass it on to you to comment on that.

I think that what you've got to bear in mind is that there's no single solution to rolling out clean energy. You've got a lot of different solutions, some including carbon capture and sequestration, some including bio-fuels, solar, wind. There's a whole broad spectrum with energy efficiency as well.

They're at different stages of maturity. So what we see is that when you look at the public markets, fund-raisings, they play a role of a particular stage in the development. So the leading sector for public market fundraising last year far and away, was solar, followed by bio-fuels. Prior to that there was a spate of activity in fuel cells, in hydrogen and wind.

So, it goes in cycles to a certain extent. There's some very real questions about what is the right sort of, who are the right equity investors for asset-intensive industries versus technology-intensive, depending on the different stages of development. So we have at the moment in the U.K. an alternative investment market called, the AIM, London Stock Exchange AIM, which has been enormously successful at attracting relatively early stage technology companies, something like $1.5 or $1.6 billion of investment was raised on London's AIM, and you don't have anything equivalent to that in the United States.

There's a number of imbalances at the moment where venture capital type investing, this sort of relay race, is not working, because the investment at the early stage is happening. But then there isn't the public market appetite here in the United States for those investments as they move on.

Mr. DENNISTON. Senator Corker, let me retrace the history of what's happened on the bio-fuels financing market for the past 12 months. In the first 9 months of 2006, there was a strong flow of capital into the sector, a lot of headlines, a lot of excitement, a lot of new plants being announced and planned, and then what happened in August and September 2006 is the commodity prices changed radically. Crude oil went from $78 a barrel to $49 a barrel in a matter of 60 days. Spot prices for corn went from $2.50 a

bushel to over $4.00 a bushel, and that sent a shock through the financial community as it relates to bio-fuels.

I will tell you that the flow of capital into the sector has slowed significantly since then, and if you look at the market capitalizations for the public bio-fuels companies, they're off significantly from their highs over the summer.

So one of the things that I asked for in my written testimony, or suggest, is a safety net—I won't talk in detail now, but a safety net for the bio-fuels community—so if the Senate believes that it's important and a strategic imperative for this country to have a domestic bio-fuel industry, where we're self-sufficient, creating our own fuels here in the United States with American farmers. Then I would submit that it would be important to look at ways to assure the sustainability and durability of the industry.

Mr. REICHER. Senator, could I just add that I urge you to think even more broadly than bio-fuels when it comes to biomass. There's a whole host of things that we can do with biomass.

It starts with very primitive technologies like just burning it to make heat and run a turbine based on that. We can gasify it, a higher-level technology; pull more energy out of it. We can turn it into liquid fuels, but even beyond liquid fuels, companies like Dupont and Dow and others are looking at biomass as a source of chemical feed stocks. Much higher value than even liquid transportation fuels, which are higher value than burning it for electricity in a fairly simple way.

So, biomass, in a way, is the modern version of a fossil fuel. It's a fossil fuel that hasn't been underground for millions of years and of course anything you could do with a fossil fuel in terms of power, fuels and chemicals, you can do with biomass. It's just that we're a lot further behind technologically.

There's one interesting thing that I mentioned at the Senate Finance Committee and I want to mention again here today. If you sequester the carbon that comes out of the conversion of biomass, essentially piggy-backing on the technology we're developing for coal, you can actually cause a net reduction in atmospheric CO_2 because the CO_2 that's bound up in biomass is the same CO_2 you've pulled out of the atmosphere when the tree grew or the corn stalk grew, unlike fossil fuels where you're releasing the CO_2 for the first time into the atmosphere. So if we develop sequestration technologies, mostly for the coal industry, we can apply those very nicely to biomass and get a net, an actual net reduction in atmospheric CO_2.

Biomass has a huge commercial potential. It also has very significant potential from a climate standpoint.

The CHAIRMAN. Senator Craig.

Senator CRAIG. And it doesn't take from the food chain.

Let's go back to John Denniston and your comments about how market shift and adjust looking at impacts as to policy shaping.

You, in your closing thoughts, John, mentioned something that was really fascinating to me, and I'll flash back to the early Clinton years when a bipartisan group of us went downtown to try to convince the Clinton administration to floor stripper wells at $13 a barrel. But it couldn't be done because somehow oil was tied to big oil and big business and nobody wanted their political fingerprints

on stripper wells. Oh, gee if we had a $13 floor, what a simple investment to make to keep a million barrels a day in production. They got closed in. They got concreted in. That's history.

A group of us have been talking about the reality of flooring—that's a term I use—certain technologies at where their break-even is or slightly above so that we don't get these distortions in the marketplace. We also know that OPEC plays a game and they watch markets and they know how to manipulate them by turning the valves on and the valves off.

It is possible, some would suggest, that we might see $45 crude or less this summer. That rippled through the markets. Why, because the $20 has come off from the $70 crude that was speculative to begin with, based on risk, I suspect.

Would the rest of you respond to what John has mentioned as it relates in developing new technologies and investing in them? Whether it's private or public dollars, or the marriage of the two, and the reality of bringing them to maturity. As this Congress now believes it is good public policy to have a large portfolio of energy, that we ought to get at the business of looking at floors, or looking at a point to break even and guaranteeing a certain level, as these technologies move into the market are stood up and arrive at a commercial level or value. Responses?

Mr. PETERS. Well, I think that's an excellent idea. I think that if we look at the history of the corn-based ethanol markets and see the very turbulent nature of both the commodity risk on the feed stock side as well as on the finished product side. We have seen cycles of tremendous growth and depressed growth, and I think that from my standpoint as one of those low-risk debt investors, to the extent that I could have a floor, some formulaic floor that would allow me to recover the cost of production plus a capital cost recovery, I would be more inclined to invest longer term at significantly lower rates.

We don't have that now. I'm one of those investors that is no longer interested in the corn-based ethanol market simply because of the market dynamics today. If you could eliminate that, I would be a full-time player in that market.

Mr. LIEBREICH. Can I suggest——

Senator CRAIG. Yes.

Mr. LIEBREICH. It is a very good idea. It needs to be carefully thought through in two ways, particularly in the ethanol space. It needs to be linked really to the spread between the raw material of feed stock and oil. So it's not just the question of the floor, it's got to be related to the spread.

Senator CRAIG. I agree.

Mr. LIEBREICH. The other thing that's very important to bear in mind is that there also needs to be a ceiling, because I think one of the goals of whatever policy is enacted has to be to continue to discriminate between good and bad technologies, and also for the investors to discriminate between good and bad management teams.

You don't want a situation where every single business plant is getting funded because the oil price is now $78 and then, the moment it dips down, you end up with a whole bunch of investors losing their money.

So, you have to think about the floor but you also have to think about, I think, the ceiling.

Senator CRAIG. You're reflective of the boom-and-bust in the tech market, and the venture capital that would do anything at one point and then got very silly and collapsed.

Mr. LIEBREICH. We saw that early in 2006 in the ethanol space, where people had no background, even in venture capital, let alone in commodities, let alone in the energy industry, were able to raise funds. I think that's very exciting when it happens, but we all know that it tends to be followed by a headache.

Mr. MUSK. Actually, if I could make a point about electric vehicles which applies to my original testimony earlier.

It only costs $3.00 to go 250 miles in an electric car. That's equivalent to having a gallon of gas at .20 cents a gallon, because electric cars are so much more efficient than gasoline cars. The electric motor in the Tesla runs at 93 percent efficiency compared with 20 percent efficiency in an internal combustion engine.

Also, I think the biomass is by far the best way, if you want to generate electricity, but by far the most efficient way is to just put biomass into a co-gen electricity station which generates better electricity at 60 percent efficiency. You could also put coal. It's basically energy source independent, sir.

Senator CRAIG. My time is up. Anyone else wish to respond to that?

Ten years ago if you'd have said that about electric cars I would have said it may have cost only that amount per mile but the extension cord is very expensive.

[Laughter.]

Mr. MUSK. You need range.

Senator CRAIG. You need range and we're getting it today.

Mr. MUSK. We have a 250-mile range.

Senator CRAIG. Thank you.

The CHAIRMAN. Why don't we just do any additional questions anyone has here? I'll go first.

I wanted to ask you, Dan, about your suggestion of the energy efficiency resource standard. One of the things we run up against, obviously, is a political reality around here. That is any time you start saying we're going to impose requirements on utilities, part of the push back is that this is the State Regulatory Commission's job, they ought to be doing it. In fact you pointed out, I think, there are eight States that have something like an energy efficiency resource standard in place now.

As an alternative to doing a national energy efficiency resource standard, what if we were to provide some Federal incentive and we can discuss what that would be, for States to do that? Basically it seems to me there are sort of three main things that State utility commissions ought to be doing to increase efficiency in the use of electricity and natural gas.

One is this decoupling between the sales and the profit that utilities can achieve. One may be something like you're describing with the energy efficiency resource standard, and perhaps a third is this feed-in tariff idea that they've adopted in Europe, that the utilities have adopted, where basically the utility says to the customer, if you go ahead and produce energy through a solar system or

through a wind system or whatever, we, the utility, will agree to buy that from you at an increased cost over what we can sell you electricity at.

Now that's been very effective in Europe. I think that again there would be a strong sentiment around here that that's something the States ought to be doing and not the Federal Government, just because that's the way things have been done historically.

What's your thought as to this idea? What can we do or appropriately do at the Federal level? Is it more appropriate for us to try to incentivize the States, State regulatory commissions to do?

Mr. REICHER. Mr. Chairman, first of all the energy efficiency resource standard, I think is a good idea and can be pursued at the State or the Federal level. We've seen in a number of States working now.

I guess I would go back to a question. We also see States succeeding with renewable portfolio standards in the same way. So, in my view actually, as a number of States have succeeded at both of these, the question has become what about a more uniform Federal approach? So I don't actually distinguish between the jurisdiction of States vis-à-vis an RPS versus an EERS, and energy efficiency resource standard.

I think we have a patchwork of State standards in efficiency, a patchwork of State standards in renewables, and we ought to adopt a broader Federal approach.

Interesting question whether you do a Federal RPS together with an energy efficiency resource standard or whether they are standalone, but I do actually feel like it's time to sort of set a floor for energy efficiency as this committee has done with respect to renewable portfolios.

Having said that, I also do agree that incentives can be a very, very effective tool for driving efficiency. I think that incentives for building codes are a good example. We have huge success with building codes in certain States and in others, they're non-existent, and that can drive a great deal of efficiency investment.

I think that the decoupling that you talked about between sales of electricity and profits is essential. States that have stepped up and moved decoupling forward have really shown that utilities can both make money and we can also reduce demand.

So, the bottom line I think is that I do in fact think we have great complementarity between renewable portfolio standards and an energy efficiency resource standard. You should consider them both at the Federal level, but I also think that incentives can drive a great deal of this as well.

The CHAIRMAN. John.

Mr. DENNISTON. Senator, great question. I have three comments.

The first is to the question of whether there's a Federal or State-by-State approach. I know that the history is State-by-State. It just seems to me that if we have a sense of urgency about solving these problems that a Federal approach has advantages to moving quicker and pushing things along much faster than State-to-State. Many States have shown leadership in this, but it just seems that the Federal approach, properly done, would have some advantages.

Second point is, I think it's very important for Congress to analyze the differences between a renewable portfolio standard and a feed-in tariff. An RPS regulates volume. Feed-in tariff regulates price. Those are two completely different approaches. Germany has gone with the feed-in tariff.

We don't have time to go through the complex differences between the two, but the one issue that I would extract from the debate for you, Senator, is that one thing I think Europe has done well in structuring their program is to give a broad range of renewable sources a chance.

So the risk of just doing a volume-based RPS is that the U.S. utilities will buy what today is the lowest-cost renewable source that by definition, will leave out other renewable sources that may have cost reduction curves in the future that beat the cost leaders today.

None of us can predict what these cost production curves will look like, but the one principle that I would urge is give a lot of different renewable sources a toe at the starting line, and let them run, and let's see over time what the cost reduction curves look like. So those would be my comments.

Mr. LIEBREICH. Could I just make a brief comment?

The CHAIRMAN. Certainly, please.

Mr. LIEBREICH. Because there's a very, very active debate in Europe about the certificate-based system, so it's equivalent of a renewable portfolio standard versus the feed-in tariff. Particularly the European wind industry is extremely keen to maintain the feed-in tariff structure.

It has been very, very kind to them. One could argue that it's been too kind to them, because it's extremely difficult to build it down in mind with the technology developments that come around in the future. So going with the more volume-based approaches, it feels like there's a lower chance of excess subsidy or excess support, but it's a very, very active debate.

It's not a debate that anybody, I think, has a single answer to, so I think I would take those two separate questions. One is what's the best answer here on that debate, and there's a separate question, which is should that then be applied at a State or a Federal level? If possible I would disaggregate those two questions, and it requires some analysis to think about the cost of any programs under those two approaches.

Mr. REICHER. And Mr. Chairman, just to follow up quickly.

The CHAIRMAN. Yes.

Mr. REICHER. The beauty of linking efficiency and renewables is that in fact if you can lower demand, that rather expensive green electron can go further. That's the point of cutting demand as we move renewables, importantly, into the mix.

We get more out of whether it's Federal dollars or private dollars going into the development of those renewable sources. So I think that's the beauty of linking efficiency and renewables in a system.

The CHAIRMAN. Senator Cantwell.

Senator CANTWELL. Thank you, Mr. Chairman. Continuing on the efficiency area, obviously one of the big advantages that we have in this energy opportunity before us is distributed generation. The notion that people can start creating sources closer to home

and delivering those energy supplies closer to home and in that as we look at incentives along the energy grid. Where do you think we should focus our attention? Because there obviously are transmission efficiencies and digitizing the grid itself, making it a smart grid.

There are incentives to businesses who might do things like smart metering, or help with net metering, and then there's incentives to consumers who may obviously invest in technology that would help them with their energy use at home. So, I don't know if you've given thought to that and whether you, the Pacific Northwest Lab came out with an estimate that you could get a double-digit savings out of energy efficiency if we made these advances and what I just call, digitizing the grid? But if you could comment on those two points. Where should the incentives be, and do you believe this double-digit savings estimate—anybody who wants to answer?

Mr. LIEBREICH. I think the attractive aspect of those ideas, those areas that you're talking about is that very often they actually have a positive payback. Energy efficiency, power saving, will actually have a positive payback, and very often the reason they're not done is because the consumers have a lack of access to either information, or lack of access to capital, or they simply don't pay back quickly enough for those consumers.

So, I think that incentives will work, perhaps, but there also needs to be a level of regulation to cause people to do even things like compact fluorescent light bulbs. People tend not to unilaterally go out and change all the light bulbs in a house even though it has a positive payback. So there is a role there I think for regulation.

Senator CANTWELL. Okay, John.

Mr. DENNISTON. Senator Cantwell. There's a very active debate within the venture capital community about whether there's an analogy between what we saw in the information technology field that went through a transition from centralized computing to distributive computing.

Senator CANTWELL. I think everybody knows the web is a distributive generation, obviously model cell.

Mr. DENNISTON. Right, exactly. So the question is, is that an apt analogy for our energy system? The arguments in favor of a future of distributive generation are what you said—efficiency—where you don't have load loss if the energy sources are localized, and there's also a security issue where you have no single point of failure.

Senator CANTWELL. But my question is and if you haven't given enough thought to it yet, is we look at this, obviously, the focus is of, given our challenges on foreign oil and other issues, how can we make this change happen?

So my question is in looking at that, where do you think the incentives should be? Should they be on transmission capacity? Should they be more to businesses or should they be to consumers, or maybe they should be on all three? I'm just curious if people have given thought to that.

Mr. REICHER. I'd say that we have an electrical system that we have today and it's going to change slowly, so in my view we do need to make transmission investments if we want to pull wind out

of the Midwest and the Pacific Northwest and move it to other regions. We need upgrades in major transmission.

At the same time incentives for distributed generation both at the commercial level and at the residential level, I think are very, very important. I think a tax incentive for onsite co-generation, smaller scale co-generation, could be very, very helpful.

I think incentivizing consumers to buy more efficient products to more web-enabled products. I mean someone talked recently, imagine a computer chip in a dryer so that on a hot day in the summer when it's 100 degrees out you have a choice. You can either, the power company can say to you, if you want to dry your clothes now, it will cost you X dollars, if you're willing to wait 4 hours when the demand has decreased significantly, it's going to cost less. These interactive, web-enabled sort of systems that frankly, my company is quite involved with, I think are very, very powerful ways to get to energy efficiency in a much faster rate then we have today.

Mr. DENNISTON. Could I just offer a very brief answer to your question? I would urge Congress to give distributed renewable energy sources a shot. I think, let the market prove it.

What I told Senator Bingaman before is what I would urge, in answer to your question, Senator Cantwell, which is, we don't know what the costs of these energy sources will look like 10, 20 years in the future. It could be that our energy system migrates toward a distributive model, but unless we get these distributed sources of generation in the marketplace, they'll have to have a very difficult time in getting there and getting there fast.

Mr. PETERS. Connecticut has an example. We have incentivized both the residential user as well as commercial developers of distributive gen to provide a renewable source of energy, while not taxing the existing distributive system, because we simply have upgraded in southern Connecticut as much as we can. We don't have any additional capacities, so the only way that we could go forward was to provide these incentives. They have been very effective for about two megawatts of distributive gen in the last 2 years.

Senator CANTWELL. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Corker.

Senator CORKER. You all are all market people and you're all putting real money out into investments albeit the industry that you're interested in is one of alternative energy and seeing growth there.

Is there a way—you know cap-and-trade is something that most of you have referred to today, and obviously cap-and-trade is one of those bought right have sold, meaning that on the front end when the deal is made you either create tremendous wealth for people just by virtue of the way you set it up, and in some cases tremendous liabilities.

But assuming that could be overcome, which is very, very difficult, is there a way in your minds, since you are market-based, to create a cap-and-trade system that doesn't slow the GDP of the United States but actually causes it to remain the same or grow? Is that just absolute, is there any way of actually doing that, and if so what would be the components of that?

Mr. MUSK. Well, I think part of it is where you set the cap and if you set the cap high enough and maybe turn that down a little bit over time that would certainly ease the burden of introducing such a system. I think that's probably a good way to go.

The details of a cap-and-trade system matter a huge amount, as I'm sure you're aware. If there's some distortion in the system, it will have a very negative effect. So I think something like that must be thought through very carefully, but I think the smart way to do it is just to start with a high cap and see what happens and then turn it down over time.

Senator CORKER. So a high cap in essence, one that has no short-term impact.

Mr. MUSK. I wouldn't say it's no, but it would be small.

Mr. LIEBREICH. I think the short answer in the short term is probably naught, because if it's working then it is taking out some of the lowest cost-generating capacity, generally coal-based, and there's going to be a cost to that, but I think you've got to take a long-term view of, if it also creates technological leadership that spurs technological leadership in the United States, or it causes the U.S. manufacturers to be at the forefront providing the equipment and the solutions.

Then I think in the long term you could see that it could be a benefit to the GDP, but I think it's a very difficult question. It is clearly something that can have a negative impact on international competitiveness, which is why I would say that engagement in the global process is critically important.

Mr. DENNISTON. I would echo that. I think there's no avoiding the fact that a cap-and-trade system or carbon tax imposes a tax on an emission that currently doesn't have a cost in the system, so you're creating a new cost in the system. The hope is that innovation and a new industry is created that counteracts the effect of the new cost being imposed on the new system.

The one analogy I can think of, Senator Corker, is the Clean Air Act of 1990 created a cap-and-trade system for sulfur emissions, and there were a number of pundits who predicted that the costs per ton of that program would be $2,000. The reality is, it's an order of magnitude less, $200 dollars a ton and it's been a very, very, very successful program. Sulfur emissions as a result of that program, single-handedly, as a result of that program are down 50 percent.

Senator CORKER. These are sort of outliers but we talked a little bit about the public markets here in our country and which is where Michael is, I think, and you guys are on the venture side and of course on the debt side.

Is that a real impediment to your companies as it relates to getting that point of equity that you're looking for in venture capital? Is the fact that that most of the alternative energy market is not based here, from the standpoint of public financing an impediment to Kleiner Perkins or other venture capital entities?

Mr. DENNISTON. I want to make sure I'm clear on the question. Is it an impediment that——

Senator CORKER. You're looking for a level of equity.

Mr. DENNISTON. Correct.

Senator CORKER. Your whole deal is to put some money in.

Mr. DENNISTON. Right.

Senator CORKER. And develop the technology, and you look for equity. Many times, most of the time, I guess, it happens in a public market.

Mr. DENNISTON. That's right.

Senator CORKER. Is the fact that the technology you're involved in mostly, the public financing for that is off shore some other place, is that an impediment to yours, to way the world is today, that simply just another place for that level of equity to take place?

Mr. DENNISTON. It's a great question. My own view is that just as we're seeing global competition for our products, we're seeing global competition in the financial services industry. I think it's a major issue for the United States. We are outsourcing a lot of financing to other countries and so many U.S. companies are now going public on the AIM for a number of different reasons, and I do think that's an issue that does need to be addressed. Yes.

Senator CORKER. May I follow up?

The CHAIRMAN. Yes.

Senator CORKER. And is that generally speaking, SOCS, or is something else that's generating that movement to London and other places?

Mr. DENNISTON. The pitch from the AIM bankers is come public on AIM, not in the United States. It will take you half the time, cost you half as much. You'll publicly report half as often, twice a year, not four times.

You won't have to comply with SOCS and we don't have a litigious environment in our country, and so SOCS is certainly a major reason. But it's a package of different things.

Mr. LIEBREICH. Senator Corker, may I add that we've done some analysis of the market performance of clean energy companies within the countries that ratified Kyoto and the countries—truthfully, the United States and Australia—that didn't, and the performance difference was absolutely stark.

I don't have the exact figures with me here, but I'm happy to follow them up as a written submission. But during 2005, there was something like a 60 percent out-performance of clean energy companies in Kyoto-ratifying countries and then there was another 30-percent-odd in 2006.

This is just too big of a difference for those people who are either financing pre-IPO, pre-public companies, or for the managers of those companies simply to say, "Well, you know we want to go on NASDAQ anyway." So, it is a fact that the European markets have been a more welcoming environment, I think for the reasons that John has explained, but also because the investors are more comfortable with those sorts of companies operating in those industries.

There's more certainty about the future, and the current levels of uncertainty about U.S. Federal policy is causing part of that. It's causing part of that migration of good companies to quote in Europe.

Mr. REICHER. Senator, could I follow up? Linking these two questions that you asked about the economic impacts of cap-and-trade and investments here in the United States, I think cap-and-trade is necessary but not sufficient. We're going to have to do an awful

lot more than cap-and-trade in terms of our own energy policy and things that this committee is looking at, even if we were to set a cap and begin to trade under it. Particularly if we want to see the investment made here in the United States as much as possible in controlling climate emissions, if we want to incentivize U.S. companies to do that.

So I think this sort of energy legislation that you're looking at here, renewable portfolio standards, efficiency standards, incentives, a whole host of things are going to be very important complements to the ultimate cap-and-trade system that I hope we adopt. But they'll also be very critical to making sure that some of the up side that we see from controlling carbon emissions come home to the United States with the investment in wind farms, the investment in other sorts of things in fact happens here, as well as other places as it needs to.

Senator CORKER. And I hear that, and that's exciting to me, but just based on the past experiences I've had at the same time it does sound like just without those certainties, we're seeing tremendous amounts of investments right now on venture capital and those technologies, so both can't be true.

Mr. REICHER. Both can't be true, meaning?

Senator CORKER. Well, I understand about the uncertainties, especially with petroleum prices fluctuating the way they are, but at the same time I see huge, huge volumes of investment going into new technologies, so both can't be true.

I mean we're seeing a tremendous escalation in investment which truly is exciting to me. We play a role in that in my own city and are excited about that, but there's, I guess, a statement you want to make about that.

Mr. DENNISTON. If that's okay? To put this into context, I don't think that the capital flows into green tech are large by any means in the context of the scope of the industries that we're talking about. They're microscopic.

So last year the venture capital industry in the United States invested $2.5 billion in green tech companies, roughly $1 billion of that were to build ethanol plants. So the core technology investment piece is roughly $1.5 billion and the energy and transportation markets in this country are $1.5 trillion, one-tenth of 1 percent, and if you think of that as the research budget that we're putting to play in this vast sector, it's microscopic. You can even add to that, DOE's annual research on renewables, which is in the couple-hundred-million-dollar range, and it's a rounding error.

So the growth rate has been large from almost nothing to $2.5 billion but relative to the scope of the problem, we're dealing with very, very, very small numbers, Senator.

Mr. REICHER. And Senator, you may have not been here when I emphasized the distinction between technology investing and project investing.

Technology investing, critical, but relatively inexpensive compared to ultimately deploying these technologies globally. We are literally talking, literally talking tens of trillions of dollars over 30 years.

However we transform our energy system, hopefully toward a more sustainable one, but just given world energy growth, given

turn over in stock, all sorts of things, we're putting trillions into this sector of energy over the next few decades. So even though as we've just heard it's absolutely exciting, heartening the increase in technology, it's going to, I think, give us a lot of benefits.

We have not seen a corresponding ramp, I think, in the level of project investment that we're ultimately going to have to get to if we really want to transform our system.

The CHAIRMAN. Do you have another question?

Senator CORKER. Just one more.

The CHAIRMAN. Go right ahead.

Senator CORKER. Obviously, and that was great testimony to put it in perspective, obviously one has to precede the other.

Mr. REICHER. Right.

Senator CORKER. The technology before you have the project. I'd like to go back to one last question with Elon, and that is: what is your production level? That is a project?

Mr. MUSK. Yes, absolutely. It's a good question actually. Basically with every new technology, you start off with low production volume and roughly high unit cost. That's why we start off with a sports car. It's $92,000, we expect to make somewhere between 1,000 and 2,000 cars a year, starting later this year. Development is essentially done, so we're just spinning up the factory to get those done.

In 2009, we'll deploy our $50,000 sedan; that's a four-door family car. That will also have a range of about 250 miles, maybe more because we're attempting to advance the energy density of the battery pack and that will be somewhere between 10 and 20,000 units a year.

Model three which will be probably a couple of years after that, that's where we'd like to get down to the $30, $35,000 range and 100,000 to 200,000 units a year, eventually getting to millions of cars per year.

Senator CORKER. And capital flow is in place to make those production levels happen at present?

Mr. MUSK. It is for the roadster and it will be, I feel quite confident for model two, which is code-named Whitestar.

Senator CORKER. Mr. Chairman, thank you for being so generous.

The CHAIRMAN. No, thank you, for having such an interest in being here. Again thank you to all of the witnesses. I think it's been very useful testimony and we will try to take your good recommendations to heart and try to do some things legislatively.

Thank you very much. That ends our hearing.

[Whereupon, at 11:40 a.m., the hearing was adjourned.]

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

RESPONSES OF JEROME P. PETERS, JR. TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. One of your primary critiques of the Department of Energy loan guarantee program is that it does not appear to take on enough of the technology risk to entice debt financing. Do analogous programs at the Department of Agriculture take on this risk?

Answer. It's not that the DOE loan guarantee program does not take enough technology risk to entice debt financing, it's that the structure of the guarantee program forces the "First Loss" risk on the lenders. By only guaranteeing 80% of the debt amount, that leaves the lender with 20% of the loan which is not subject to the guarantee. The real problem with the DOE structure is that upon a call on the guarantee, the DOE now has a first lien on the project assets and the lender cannot recover the 20% un-guaranteed amount until the DOE has fully recovered their guarantee payout, almost surely resulting in the lender loosing 20% of the loan amount.

In customary "project finance" loans, the lender is given the first lien on all of the project assets and if a guarantee is not sufficient to repay the debt in its entirety, the lender can liquidate the assets to make up the balance. Many lenders, including TD Banknorth N.A., might be willing to accept a DOE loan guarantee program that only covers 80% of the loan amount but only if they maintain the first lien status and the rights to liquidate the assets to recover their loan oustandings. In many cases a total "call" on the DOE loan guarantee may not be needed. We may only need enough to "fix" the project so that it can "earn" its way through the repayment of the debt. Again, under the current DOE guidelines, this would not be possible. To my understanding the USDA Business and Industry Guaranteed Loan Program resolve this risk.

Question 2. Given that we are trying to push to commercialization generally unproven technologies with some inherent uncertainty about their eventual success, do you have some thoughts on how the government could manage risk to the taxpayers while still fulfilling the financing needs currently going unmet by private lending?

Answer. I will again revert back to an analogous program at the Overseas Private Investment Corporation which takes on risks unmet by private lending. It is nearly impossible for private lenders to assess, much less mitigate, the sovereign risk involved with foreign government backed loan guarantees. OPIC mitigates such risks by charging lenders/sponsors ongoing fees to guarantee the obligations of such governments based upon the relative risk that each government poses for non-payment. In the same Way, the DOE would charge technology guarantee fees based upon the relative risk presented by each technology. More advanced technologies like fuel cells and IGCC might carry lower fees while less advanced technologies would carry higher fees. I would not rule out the possibility that the DOE might be able to obtain some sort of "equity kicker" for providing guarantees to some of the more risky technology deployments, much like what technology funds receive for early technology investments.

RESPONSE OF JEROME P. PETERS, JR. TO QUESTION FROM SENATOR AKAKA

Question 3. What is the proper role of government and private sector financing for large advanced alternative energy production plants? How should technology-specific federal loan guarantees be structured?

Answer. The role of government and the private sector differ significantly in the financing of large advanced alternative energy production. The private sector will always invest if they believe that they can get an adequate return on their investment given the risks that they have to take. The higher the risk the higher the re-

turn expectations. During any commercialization process, there are very high risks associated with scale-up and operational costing. These risks are usually taken by venture capitalists but carry the cost of very high rate capital.

Initially, most new technologies cost more to build and more to operate than existing technologies until those costs are reduced through the expected economies achieved through commercialization. Historically, alternative energy production has had to compete with conventional energy production on a cost of production basis. It is doubtful that large scale new technology deployment will be successfully achieved given its higher capital and operational costs. Technology grants and technology guarantees from governments can often level the playing field and enable new technologies to gain a foothold against existing energy infrastructure until such time as the commercialization economies are achieved.

Since the risks associated with new technology deployment vary by technology, it seems reasonable that the structure and the type federal guarantee might vary as well. I will explain by example. The technology risks associated with the deployment of cellulosic ethanol projects differ greatly from the technology risks associated with the deployment of utility scale fuel cell projects. Utility scale fuel cell projects are much further along the technology development timeline than cellulosic ethanol projects.

While there are many unknowns in the commercialization of cellulosic ethanol production, (capital cost per unit of production, operating costs, collection and storage of cellulosic material to name a few) there are far fewer unknowns with utility scale fuel cell commercialization. A complete federally backed loan guarantee program along with technology grants may be required to permit the deployment of large scale cellulosic ethanol production to enable it to compete with existing corn based ethanol production. With most scale-up questions already answered, utility scale fuel cell projects may not need a loan guarantee program and may only need the have the federal government guarantee stack replacement intervals which could be significantly less costly to the government than an 80% loan guarantee if called.

There are many other examples of technology specific solutions which could potentially be less costly and less capital intensive (appropriations) which could be applied to enhance new technology deployment. The establishment of a dialogue between the stakeholders (government, technology providers and investors) will be necessary to identify the risks, either real or perceived, of each technology and to develop appropriate programs to mitigate them.

RESPONSES OF JEROME P. PETERS, JR. TO QUESTIONS FROM SENATOR SALAZAR

Question 4. When we look at a Renewable Portfolio Standard (RPS) and look at changing the Renewable Fuels Standard (RFS) in this committee as part of our energy bill, what does that do in terms of the private market looking at investments in the renewable energy area?

Answer. There is no question that the combined implementation of a national Renewable Portfolio Standard (RPS) and a national Renewable Fuel Standard (RFS) would significantly increase the pace of growth of the renewable energy industry in the United States. Investors in the renewable energy projects would take great comfort in knowing that there will be a continued need for the renewable product produced by their projects and that the products themselves would not necessarily have to compete on the same cost basis as conventional energy products due to the RPS/RFS requirement.

The traditional way our government has provided incentives for new investment in renewable energy infrastructure projects has been through the granting of tax incentives (investment and production tax credits and accelerated depreciation). The major problems with tax incentives is that (1) you have to be a current taxpayer to be able to utilize the tax credits and (2) the incentive programs have lapsed several times in the past 20 years causing fits and starts in project investment. Many technology developers have invested significant amounts of capital in the technology development phase with little or no revenue coming through the door. These accumulated losses negate the benefit provided by the tax credits. Most projects are thus sold by their developers to "Tax Investors" who require a premium return on their investment in return for utilizing their "tax base".

The implementation of an national RFS/RPS would provide a long term stable growth environment for renewable energy investment. The free market atmosphere afforded by a national RPS/RFS would allow renewable energy technologies to compete against each other and not with conventional energy. Provisions could be made to allow emerging technologies a chance to compete early in their development cycle by providing a "modifier" for energy produced by that technology much like what is currently contained in the RFS for cellulosic ethanol.

By far the most beneficial attribute to a national RFS/RPS would be the elimination of tax incentives which would create a level playing field for all investors and lower the cost of capital for these projects by opening up the investment market to all investors regardless of their tax base.

Question 5. Loan guarantees have been discussed as an important federal incentive to drive clean energy development. Titles 15 and 17 of the Energy Policy Act of 2005 authorize the Department of Energy to provide loan guarantees for energy projects that employ new or significantly improved technologies to avoid, reduce, or sequester air pollutants or reduce greenhouse gas emissions, and the FY 2008 budget proposes implementing a loan guarantee program that includes $4 billion in loans for projects that promote biofuels and clean transportation fuels. In my opinion, the Department of Energy has been slow to implement this program in a manner that best supports this industry. Can you address ways that this loan guarantee program could be improved to spur the use of cellulosic biofuel projects?

Answer. There are three problems with the current federal legislation including loan guarantee program pursuant to Titles 15 and 17 of the Energy Policy Act which will negatively affect the development of cellulosic biofuels: (1) the guarantees are unfunded, (2) the DOE's program is flawed (see answer 1) and, (3) the current RFS standards have already been achieved.

The Congress needs to fund the guarantee program and fix the flaws in the DOE guarantee program before any investment will come from the private sector into cellulosic biofuels production infrastructure. Given cellulosic ethanol project's higher capital costs, it is not likely that those projects can compete with corn based ethanol production in the near. Congress, through the passage of a new RFS with a similar cellulosic "modifier" would allow cellulosic ethanol to compete.

Question 6. Can you explain further how you envision Congress working with the utility sector to develop incentives to encourage the utilities to promote energy efficiency with their customers?

Answer. I do not feel as though I am qualified to answer this question.

Question 7. 25 Senators and 46 Representatives have endorsed the 25 x 25 initiative to get 25% of our energy from renewable sources by 2025. Do you have suggestions for policies Congress should consider that would help us meet this 25 x 25 goal?

Answer. Various states have set renewable energy goals and have backed them up with meaningful RPS's. I certainly don't see why the federal government could not draft a national RPS which could achieve a 25% renewable source content in the next 25 years. History has proven that when states have set a renewable energy use goal but have not mandated a RPS that the states have failed in achieving the milestones that they have set. In states where the renewable goal is backed up by an RPS, those states have met their milestones. (NY and CA as examples).

Question 8. In your testimony, you discuss how alternative energy technologies are at a disadvantage because they have to compete for the same capital against fossil fuel technologies, which may have significant "externalities," such as security concerns and environmental footprint that are not priced in the cost of that fossil fuel. What effect would a reasonable price on carbon have on the economics of alternative energy technology demand? What is the most efficient way to put a price on carbon?

Answer. In addition to a national RPS, a national carbon tax or a cap and trade programs are both excellent means to provide that level playing field to allow clean and renewable energy to compete with conventional fossil fuel energy. A carbon tax program could be developed to create a system of transfer payments from carbon emitters to renewable and clean energy producers thus making the carbon emitters pay the true cost of their energy production. The problem here is setting the proper price for that carbon emission.

I prefer a "cap and trade" approach to carbon emissions where the free market system set the price for carbon emissions.

Question 9. We hear a lot of talk about the need for next generation energy technologies to address greenhouse gas emission reductions and the role of federal policies to achieve that goal. To what degree can Congress help bring these new technologies to market in the absence of a market signal such as a cost on carbon emissions?

Answer. Again I believe a properly structured carbon cap and trade program would provide sufficient incentive to those "next generation" of energy projects which will either sequester or not emit carbon. When deciding how to replace existing fossil fueled energy production or when adding new production, the generator must take into account the market price for the carbon credits either avoided or added. In either case, that market price for emitted carbon will dictate the technology choice.

RESPONSES OF JEROME P. PETERS, JR. TO QUESTIONS FROM SENATOR DOMENICI

Question 10. You note in your testimony that the USDA loan guarantee program is properly structured. Can you describe the elements of that program that you believe make it successful?

Answer. The USDA Business and Industry Guaranteed Loan Program as I understand it, provides a full guarantee of the loan amount for up to 80% of project cost. The full guarantee level avoids the lenders need for a first lien position.

Question 11. You note that some emerging energy technologies, such as fuel cells and solar power units, have difficulties entering the market because of uncertainty about their useful lifetime. How can the government help these technologies enter this market?

Answer. In certain technologies, the lenders may need a loan guarantee for the full amount of their debt due to the possibility of a complete failure of the technology to deliver cost competitive products such as in cellulosic ethanol projects. The two main risks associated with cellulosic ethanol projects are the fact that no one has built, and no one operated, a commercial scale project to date. Therefore no one really knows how much it will cost to build a project and no one really knows how much it will cost to actually produce a gallon of cellulosic derived ethanol.

In the case of utility scale fuel cells and concentrated solar thermal/PV projects, the primary risk issue is related to the expected life of the components that make up the projects. In the case of fuel cells, stack life expectancy and degradation in efficiency are the primary risk issues. Solar cell life expectancy (concentrated solar PV issue) and durability in tracking systems (solar thermal issues) are the main risk issues in solar projects which are difficult for lenders to get comfortable.

Most of the companies which are developing these technologies have demonstrated that their products work quite well and that they can deliver these products at a predictable cost. They have not been able to demonstrate, to the satisfaction of private lenders, that their products will last 20 or 30 years and will not degrade significantly over time. This is due to the fact that their existing fleet of demonstration projects have not accumulated enough operating time to prove the point of long term durability and reliability. Most, if not all of these technology companies, lack the financial strength to provide a meaningful (and acceptable) long term warrantee on their products.

I believe that, while the government could provide a full loan guarantee, which would certainly satisfy most private lenders, a lesser level of government support would satisfy most lenders. The government may decide that is less costly to back the technology providers long term warranties on its concentrated solar panels or back guarantees of fuel cell manufacturers stack replacement intervals.

Under a worst case scenario, the government might find itself in the position of paying for a few extra solar panels to make up for ones that fail or paying for replacements of fuel cell stacks every 4 years rather than every 5 years. The government might want to limit its total exposure to no more than 80% of the project cost which would be acceptable to most lenders. I believe that the potential long term risk exposure to the government under this type of guarantee program would be much less than a flat 80% federal loan guarantee.

RESPONSES OF JEROME P. PETERS, JR. TO QUESTIONS FROM SENATOR THOMAS

Question 12. At the hearing, every witness advocated for some form of federal subsidies to advance energy technologies. I believe that the central theme of the hearing was, primarily, how we get private companies to unleash their ingenuity as part of a free market, however. I am concerned about this tendency to advocate for more government intervention. The question I'd like to see answered is how we achieve advanced energy technologies with minimal government intervention. We can, and should, advance energy technologies by doing something other than spending taxpayer money. We can look at automobile mileage, streamlined facility permitting, modernized efficiency standards, and federal assumption of liability for demonstration projects. I do believe we must do these things in the absence of a price on carbon too, given that those costs will merely be passed along to consumers. In that context, can you provide some purely regulatory approaches that you believe would advance energy technologies without requiring a significant expenditure of federal dollars through direct appropriations, tax credits, or other forms monetary support?

Answer. I have no answers to this question.

Question 13. You stated in your testimony that the DOE Loan Guarantee Guidelines prohibit the substitution of equity to make up for un-guaranteed debt. Can you provide some examples of equity that could be used to offset the 20% required of applicants? Do you believe that a coal seam, to be used as a feedstock for a project, should qualify?

Answer. According to my interpretation of the DOE guidelines, additional equity cannot be contributed so as to offset the 20% un-guaranteed portion of the project debt. I would assume, that provided the purchase of the coal seam was part of the qualified "Project Cost" that its contribution by the sponsor in lieu of cash should qualify a equity as defined in the DOE guidelines.

Question 14. You spoke of the need to establish goals that advanced energy technologies should seek to accomplish. At the end of your written testimony, however, you discuss technology-specific federal backing that may be needed. Can you clarify for us as to what approach you believe is most appropriate? I am concerned that politicians, myself included, and not the free market may end up choosing the technological winners and losers.

Answer. I believe that we as a nation should choose, through our elected representatives, what goals we want our renewable technologies to achieve. If we, for instance, choose that cost of production is the most important criteria, then we must choose the lowest cost technology. This has been the case for the last 10 years as state and regional utilities have held competitive bidding solicitations for renewable power generation. Wind generation has won the vast majority of these solicitations on the basis of cost alone. It is currently the cheapest technology to deploy and operate and was the only viable technology benefiting from the Production Tax Credit until the passage EPA 2005.

If on the other hand, we decided as a nation, that base load power capabilities and utilization of our nations huge coal reserves was the objective, then different technologies would be chosen which may not be the cheapest to install of operate. My belief is that we as a nation must deploy many diverse technologies in order to achieve a wide range of objectives from reduction of greenhouse gases to providing more efficient base load power. Only then can we begin to allow the commercialization process to determine the cost effectiveness of each technology.

RESPONSES OF MICHAEL LIEBREICH TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. You mention as a primary constraint on investment in the United States the lack of policy certainty with regard to clean energy. In your survey of markets in other countries have you encountered policy regimes that were particularly effective in spurring investment in clean energy?

Answer. New Energy Finance is not a public policy think tank and it is not our role to render judgement on which clean energy incentives, mandates, or subsidies have accomplished the overarching goals of promoting energy independence or reducing greenhouse gas emissions. However, since our firm specialises in tracking capital flows in clean energy, we can speak with some authority on which programmes have successfully sparked investment activity. Below is a glance at key policies around the globe.

In Germany, a generous feed-in tariff scheme for solar power development has created its intended ramp in production and consumption. Currently, the country dominates the world PV market, making up an estimated 44% of all new build photovoltaic installations in 2006 and driving up module prices worldwide. This has been achieved through a feed-in tariff of $0.61-0.75 per kilowatt hour, and a tax credit system for individuals. While smaller systems get a higher feed-in tariff than large ones, the difference is not sufficient to preferentially incentivise distributed generation, and so the German market is slanted towards utility-scale power plants on agricultural land.

The aim of the tariff was to foster the domestic PV manufacturing industry, which indeed has seen incredible growth since 2004. But the tariff declines 5% per year, and that has begun to slow the German market. Moreover, there are questions over whether Germany was the right place for such a generous tariff programme given the country's unspectacular solar resources. Today, Germany's manufacturers are struggling to diversify their markets to find more than just domestic sales. And they are encountering stiff competition for large contracts from lower cost producers in China.

In Spain, the government is also supportive of photovoltaic installations on residential roofs and the development of large-scale grid-tied solar thermal electricity generation (STEG) projects that employ mirrors to generate heat and turn a turbine. In fact, the country has a set a goal of 500MW of STEG capacity by 2010.

Under existing law, power generated from photovoltaic systems under 100kW in size in Spain can be sold for nearly six times as much as power generated from other sources. This has led to large-scale projects set up as multiple 100kW legal entities. The law is expected to be reviewed in the next few months, but the market is growing fast.

Brazil's support for the use of alternative fuels is often cited as a great success by ethanol supporters in the U.S. and elsewhere. But the country's experience with clean fuels has seen its share of ups and downs.

In response to the oil crisis of the 1970's, the government initiated two parallel policies: increased oil prospecting and increased substitution of ethanol for gasoline. This programme began with a mandatory 10% ethanol/gasoline ("gasohol") blend, which has since increased to between 20-25%, set annually by the government.

The trajectory from 1975, when the programme began, to 2007 has been discontinuous. By 1985, more than 90% of cars produced in Brazil ran on ethanol—but at a high cost to the government in the form of ethanol subsidies. These subsidies proved difficult for the government to sustain as oil prices fell. When the government relaxed car import regulations and reduced subsidies on the ethanol in the 1990s, many consumers took the opportunity to switch to imported gasoline cars. Flex-fuel vehicles had not at that time been developed, meaning that consumers were tied either to gasoline or ethanol. Local car producers were forced to adapt. By 1995, less than 5% of cars produced in Brazil used ethanol.

Though falling oil prices had severely constrained demand for ethanol, it did not destroy the industry. Brazil's ethanol was produced primarily by family-owned sugarcane processors. These companies regarded ethanol primarily as an alternative end use to their product, so when sugar returns were higher than ethanol returns, they would sell sugar, and vice versa. Today, the most advanced plants can switch from producing one to the other in around an hour.

It was the introduction of flex-fuel vehicles that revitalised Brazil's ethanol programme. In January 2004, FFVs made up a little more than 10% of new light vehicle sales; by January 2006, they accounted for almost 80%. FFVs allowed consumers to buy whichever of ethanol and gasoline was the cheapest, and to run on any mixture of the two. Not tying them into a particular fuel was evidently the way to persuade consumers to accept ethanol through the market—but, of course, with the implication that demand could dry up during a sustained period of low oil prices.

In China, the country's National Reform and Development Committee has set developmental goals for the country's renewable sectors for the next decade to meet increasing energy demand and support a sustainable economy. As of 2005, 7.7% of the country's primary energy use came from renewable sources (including large-scale hydro) and the government has aimed to up that to 15% by 2020.

To accelerate the development of renewables, Chinese officials have announced plans to institute pricing mechanisms for wind, solar, tidal, geothermal, biomass and hydro power. Officials say consumer electricity rates will increase as the country's citizens bear the cost of producing power more cleanly.

The government has also taken steps to insure that the economic benefits of the development of clean energy projects stay within China. For instance, a minimum of 70% of the parts in a utility-scale wind turbine installed in China must be originated in the country. This rule has compelled foreign wind turbine manufacturers to partner with local companies in China in order to build out manufacturing capacity there.

Question 2. in your observations of other countries' public incentives for development of clean energy technologies how have you seen other countries manage the risks of investing in unproven technologies?

Answer. Please see above.

Question 3. I'm intrigued by your comments about the effect on domestic investment in clean energy technologies of ratifying the Kyoto Accords. Can you give us some more information on what you've seen?

Answer. New Energy Finance closely follows the performance of approximately 80 publicly-traded companies worldwide with a direct involvement in clean energy through our WilderHill New Energy Global Innovation Index, which can be tracked under the ticker "NEX". The NEX includes a representation of the world's top wind turbine manufacturers, solar cell producers, fuel cell developers, and other companies with a significant involvement in clean energy.

We have found that NEX companies that trade on exchanges in countries that are signatories to the Kyoto accords have performed better than those trading on markets in countries which did not sign. Over the course of 2006, Kyoto country stocks in the NEX gained 49%. Meanwhile, non-Kyoto country stocks in the NEX rose 8%. Clearly, investors have expressed a higher degree of confidence about companies trading in Kyoto country markets.

Responses of Michael Liebreich to Questions From Senator Akaka

Question 4. You were quoted in Investment Dealers Digest (Feb, 12, 2007) as saying "2007 will be a critical year for the clean-energy industry. There has been no

shortage of capital, but now the industry has to deliver cost-effective power and fuels in large volume." If capital is not an obstacle, what in your opinion, constrains large power and fuels production?

Answer. In that comment, I was referring to the fact that over the past 18-24 months, an enormous amount of venture capital has been poured into early-stage technologies that have the potential to revolutionise the energy infrastructure. The onus is now very much on the firms that have received venture backing to prove their technologies are viable. This will require a tremendous amount of research, development, creative thinking, and hard work.

But technologists and entrepreneurs are not the only ones facing challenges. Those who run the existing energy infrastructure are being forced to adapt to a carbon-constrained world. For them, integrating renewable resources into the grid poses a new challenge—significant and unpredictable variability. By their very nature, wind and solar projects offer intermittent sources of energy—when the wind doesn't blow, a wind farm doesn't produce. As more such projects come on line, utilities will be forced to find innovative ways to integrate them into the existing power pool to insure demand is met seamlessly.

For policymakers, the challenge going forward will be to create streamlined policies that not just promote renewables but "get the rocks off the rails," as Assistant Secretary for Energy Efficiency and Renewable Energy at the Department of Energy Alexander Karsner so often says. That could mean expedited permitting processes for clean energy projects or the establishment of national transmission corridors such as the two recently announced by the DOE.

Finally and inevitably, consumers themselves will be forced to make some adjustments to living in a carbon-constrained world. This may mean taking the steps to improve efficiencies in their homes by purchasing compact fluorescent light bulbs or replacing drafty windows. It might mean thinking twice before objecting to a local wind farm based on NIMBY concerns. Or it could mean learning to accept slightly higher monthly electricity bills that result from their state's commitment to clean energy and energy efficiency.

Question 5. You were also quoted as saying, "We need efficient, minimally-distorting policy support frameworks." What would be an example of this?

Answer. I believe the best policies are, in effect, technology agnostic, i.e. they don't promote the use of one particular clean energy technology or fuel. Rather, they set certain targets for an industry or a region to achieve then leave it to the free market to work out how best to reach the goal.

Governor Arnold Schwarzenegger of California's Low Carbon Fuel Standard is an intriguing example of a technology agnostic policy. In January, the Governor issued a directive requiring that passenger vehicles in California reduce the carbon intensity of their emissions by at least 10% by 2020. It is my understanding that Governor Schwarzenegger intends to leave it largely to industry to sort out how to achieve the target.

Responses of Michael Liebreich to Questions From Senator Salazar

Question 6. When we look at a Renewable Portfolio Standard (RPS) and look at changing the Renewable Fuels Standard (RFS) in this committee as part of our energy bill, what does that do in terms of the private market looking at investments in the renewable energy area?

Answer. Raising and extending the U.S. standard could boost investor confidence in the longevity of the U.S. biofuels sector. Over the last six to nine months, major banks and private equity firms have retreated from financing new ethanol plants after corn prices climbed above $4 a bushel. Those higher feedstock prices have shrunk producers' margins and also raised fears on Wall Street that publicly-traded ethanol firms are over-valued. A higher RFS could convince investors that there will be a strong market for ethanol longer term, regardless of short-term corn or ethanol prices.

Question 7. Loan guarantees have been discussed as an important federal incentive to drive clean energy development. Titles 15 and 17 of the Energy Policy Act of 2005 authorize the Department of Energy to provide loan guarantees for energy projects that employ new or significantly improved technologies to avoid, reduce, or sequester air pollutants or reduce greenhouse gas emissions, and the FY 2008 budget proposes implementing a loan guarantee program that includes $4 billion in loans for projects that promote biofuels and clean transportation fuels.

Answer. Energy Finance does not directly offer debt financing clean energy companies or projects and thus I have had no direct experience with DOE's loan guarantee programme.

Question 8. In my opinion, the Department of Energy has been slow to implement this program in a manner that best supports this industry. Can you address ways that this loan guarantee program could be improved to spur the use of cellulosic biofuel projects?

Answer. Energy Finance does not directly offer debt financing clean energy companies or projects and thus I have had no direct experience with DOE's loan guarantee programme.

Question 9. Can you explain further how you envision Congress working with the utility sector to develop incentives to encourage the utilities to promote energy efficiency with their customers?

Answer. It strikes me that to a large extent there is little Congress can do directly to compel utilities to pursue energy efficiency programmes since utilities are primarily regulated by state public utility commissions. However, Congress could provide encouragement to both utilities and their regulators to pursue responsible policies that promote energy efficiency measures such as "de-coupling."

Question 10. 25 Senators and 46 Representatives have endorsed the 25 x 25 initiative to get 25% of our energy from renewable sources by 2025. Do you have suggestions for policies Congress should consider that would help us meet this 25 x 25 goal?

Answer. A federal renewable portfolio standard that codifies those goals is one possibility. Another would be a comprehensive and aggressive cap-and-trade programme that mandates major cuts in greenhouse gas emissions. Such a programme would inevitably spur the development of more clean energy projects as utilities and other emitters seek to shrink their overall "carbon footprints" by purchasing power from clean sources.

Question 11. In your testimony, you've discussed how alternative energy technologies are at a disadvantage because they have to compete for the same capital against fossil fuel technologies, which may have significant "externalities," such as security concerns and environmental footprint that are not priced in the cost of that fossil fuel. What effect would a reasonable price on carbon have on the economics of alternative energy technology demand? What is the most efficient way to put a price on carbon?

Answer. Please see my prior written testimony to the committee, section six, item 5.

Question 12. We hear a lot of talk about the need for next generation energy technologies to address greenhouse gas emission reductions and the role of federal policies to achieve that goal. To what degree can Congress help bring these new technologies to market in the absence of a market signal such as a cost on carbon emissions?

Answer. I would argue there are a number of such options at policymakers' disposal to promote the development of clean energy. Please refer to questions 1, 5, 10 and others here for examples.

Responses of Michael Liebreich to Questions From Senator Domenici

Question 13. In your written testimony, you note that the United States out-invested Europe by a factor of three in "early stage technology" investing, while Europe invests more heavily in technology deployment measures. If this trend continues, is it likely that technologies originally developed in the United States will be manufactured in Europe for their market, creating European jobs?

Answer. That is an undeniable possibility, given the nature of the global economy. However, I would argue that it is more likely that nations with substantially lower pay scales stand to benefit more than Europe. China, for instance, has virtually overnight become a major player in manufacturing the equipment used in photovoltaic panels. Today, there are no fewer than five Chinese solar companies trading on major U.S. exchanges with potentially more to come.

However, the nature of the global economy also offers opportunities for U.S.-based manufacturing. For years, major wind turbine makers have resisted investing to expand capacity in the U.S., primarily based on concerns tied to the on-off nature of the federal Production Tax Credit. With PTC extension now regarded as more likely, attitudes may be changing. Indian wind turbine maker Suzlon, for instance, today makes turbine blades and nose cones at a facility in Minnesota. In March, Danish turbine maker Vestas announced plans to open a $60 m plant in Colorado. And Spanish turbine maker Acciona plans to open a facility in Iowa later this year.

Still, the majority of manufacturing of wind turbine components for projects in the U.S. today takes place overseas. Should Congress pass a long-term PTC extension, we could see further capacity build out in the U.S. to meet expected demand.

Question 14. In your testimony, you noted that U.S. CEOs choose to locate energy technology firms in Europe because of greater perceived sophistication among energy investors. How can we address these perceptions?

Answer. To clarify, what I intended to communicate is that in the past we have seen U.S. companies float their shares on overseas exchanges such as the London Stock Exchange's Alternative Investment Market (AIM). The perception has been that investors in Europe were more receptive to clean energy ventures because Europe has shown greater commitment to cutting greenhouse gas emissions than the U.S. In addition, the provisions of the Sarbanes-Oxley law generally do not apply to U.S. companies who list on AIM, so going public there is less expensive for small firms than debuting on NASDAQ or on the New York Stock Exchange.

There are some signs that may be beginning to change, however. Over the past 12 months, we have seen more U.S.-based solar, biofuels, and other companies list their shares on U.S. exchanges. Clean energy has been widely identified as a "hot" area for investing in the U.S. in recent months. As discussed above, we are also seeing foreign firms such as Chinese photovoltaic equipment makers listing on the U.S. exchanges to tap into opportunities.

Looking ahead, the establishment of a comprehensive long-term policy framework would demonstrate to the world that the U.S. is committed to promoting clean energy and to cutting carbon emissions. It would appear that this committee and others on Capitol Hill are well on their way toward building such a framework.

RESPONSES OF MICHAEL LIEBREICH TO QUESTIONS FROM SENATOR THOMAS

Question 15. At the hearing, every witness advocated for some form of federal subsidies to advance energy technologies. I believe that the central theme of the hearing was, primarily, how we get private companies to unleash their ingenuity as part of a free market, however. I am concerned about this tendency to advocate for more government intervention. The question I'd like to see answered is how we achieve advanced energy technologies with minimal government intervention. We can, and should, advance energy technologies by doing something other than spending taxpayer money. We can look at automobile mileage, streamlined facility permitting, modernized efficiency standards, and federal assumption of liability for demonstration projects. I do believe we must do these things in the absence of a price on carbon too, given that those costs will merely be passed along to consumers. In that context, can you provide some purely regulatory approaches that you believe would advance energy technologies without requiring a significant expenditure of federal dollars through direct appropriations, tax credits, or other forms monetary support?

Answer. Governments have a slew of ways to spur clean energy growth without direct government spending in the form of tax credits or subsidies.

Mandates requiring consumption levels of certain cleaner-burning fuels (a renewable fuel standard) or certain cleaner sources of energy (a renewable fuel standard) do not cost taxpayers directly. Rather, they set certain benchmarks for industry to achieve on their own, presumably with the help of private investment. In addition, government can take specific steps to streamline the permitting for certain projects it deems of high importance (see question four).

Question 16. You testified about your belief that the U.S. has strong programs in clean coal. Can you explain what you believe the economic and policy reasons are for a coal-to-liquids facility having not been built yet here in the United States? We're told it's because people haven't done it yet. How are the plants in China and South Africa any different than what we'd build here? Why isn't there private sector money available for coal-to-liquids plants given that it's been done in other countries?

Answer. To understand why there has not been more development of CTL projects in the U.S., it is instructive to look at the reasons behind their construction abroad.

In the case of South Africa, the state oil company backed CTL because the country was, in effect, isolated from the international community and could not easily import crude. South Africa's need for energy independence trumped whatever concerns there might have been about the environmental impact of converting coal to liquid fuel.

In China, the high rate of economic growth has created an insatiable thirst for liquid fuel. Much has been written about the environmental conditions in China and the fact the country is bringing one new coal-burning plant on line per week. The country is showing similar disregard for the environment in the construction and operation of CTL facilities. In both South Africa and China, as in Nazi era Germany decades ago, energy independence concerns have been a driving force in the construction of CTL capacity.

In the U.S., for decades there was no economic impetus for CTL since the price of imported or domestically-produced crude was so low. Today, with oil prices in the $60 to $70 barrel range it is understandable that CTL is getting a serious look, given the U.S.'s increasing desire for energy security and independence.

However, building a new CTL plant is highly capital intensive. Among the relatively small number of players with the resources to finance such projects are the major oil companies and they would appear to have little interest in promoting a competitor fuel.

In addition, there appears to be a growing consensus within the U.S., particularly in the power generation sector, that the federal government will impose some kind of cap on carbon emissions. Calculating the potential cost of complying with any new "cap-and-trade" regime is nearly impossible for potential backers of CTL plants and introduces far too much risk into the equation.

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