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S. HRG. 111–729

PROMOTING A CLEAN ENERGY ECONOMY

HEARING

BEFORE THE

JOINT ECONOMIC COMMITTEE
CONGRESS OF THE UNITED STATES

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

JULY 27, 2010

Printed for the use of the Joint Economic Committee

U.S. GOVERNMENT PRINTING OFFICE

58–299 WASHINGTON : 2010

For sale by the Superintendent of Documents, U.S. Government Printing Office,
http://bookstore.gpo.gov. For more information, contact the GPO Customer Contact Center,
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VerDate Nov 24 2008 10:14 Dec 08, 2010 Jkt 058299 PO 00000 Frm 00001 Fmt 5011 Sfmt 5011 C:\DOCS\58299.TXT SHAUN PsN: DPROCT

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PROMOTING A CLEAN ENERGY ECONOMY

TUESDAY, JULY 27, 2010

CONGRESS OF THE UNITED STATES,
JOINT ECONOMIC COMMITTEE,
Washington, DC.

The committee met, pursuant to call, at 10:05 a.m. in Room 216 of the Hart Senate Office Building, The Honorable Carolyn B. Maloney (Chair) presiding.

Representatives present: Maloney, Hinchey, Cummings, Snyder, Brady, Burgess, and Campbell.

Senators present: Bingaman.

Staff present: Andrea Camp, Gail Cohen, Colleen Healy, Kinsey Kiriakos, Jessica Knowles, Jane McCullough, and Ted Boll.

OPENING STATEMENT OF THE HONORABLE CAROLYN B. MALONEY, CHAIR, A U.S. REPRESENTATIVE FROM NEW YORK

Chair Maloney. The meeting will come to order. I would like to recognize myself for my opening statement. I welcome my colleagues and the panelists.

I am pleased to hold today's hearing on promoting innovation in the clean energy sector. This is the second in a series of hearings held by the Joint Economic Committee on the role that innovation has in fueling employment and growth.

Innovation in the clean energy sector will improve productivity, enhance job creation, and improve the quality of life.

This hearing is timely for a number of reasons:

The Senate plans on discussing energy legislation this week;

The nightly news and the camera footage of the Gulf oil spill remind us of the human and environmental cost of the spill;

While our economy is still raw from the devastating job losses experienced in the Great Recession, it is obvious that more robust growth is needed to reduce the unemployment rate. Innovation in the energy sector can help fuel growth in the future.

Innovation in the clean energy sector can also strengthen the economy by making it less vulnerable to economic downturns. While the United States has weaned itself from dependence on oil in many sectors, progress to reduce our dependency on oil to meet transportation needs has been particularly slow.

At a hearing last May, Dr. James Hamilton testified that the oil price run-up in 2007–2008 was an important factor that contributed to the Great Recession. He testified that the run-up in oil prices caused a plunge in auto sales, deterioration in consumer sentiment, and a slowdown in consumer spending and problems in

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housing, especially in the exurbs where commuting costs can rise significantly with gasoline price increases.

Continued reliance on oil leaves the economy vulnerable to sharp increases in oil and gasoline prices and could potentially derail the economic recovery that we are now experiencing.

It appears that when oil expenditures reach 4 percent of GDP, the U.S. is at risk of falling into a recession. And that is what our chart shows—that in every major recession except one, oil price played a major role.

[The chart titled "Oil Expenditures" appears in the Submissions for the Record on page 40.]

Currently the share of GDP spent on oil is 3.5 percent, much higher than in 1993 when the share of GDP spent on oil was 1.8 percent, but better than the 6.8 percent in mid-2008.

Innovations in the clean energy sector can reduce our vulnerability to oil price rises. These innovations may arise from a variety of different sources:

New technologies to produce energy;

New forms of energy, production of existing fuels, or energy in a cleaner or a more efficient manner; or

New ways of reducing our consumption of energy.

In our hearing last month on innovation, witnesses testified that federal spending on basic research in universities can provide the spark that ignites regional economic growth and job creation.

Universities, with help from venture capitalists, have emerged both as producers of ideas and active players in the innovation chain, creating start-ups that are among the most successful small businesses. But witnesses at our last hearing also testified that there is not enough funding or research in the energy sector.

Congress and the Administration have recently increased our country's commitment to clean energy. The Recovery Act invested more than $90 billion in clean energy, including investments in energy efficiency, advanced vehicles, clean energy equipment manufacturing, and mass transit and high-speed rail.

Additionally, the America COMPETES Act, passed by the House on May 28th, supports innovation and basic research by creating new clean energy consortiums in a public-private partnership.

America COMPETES also provides a much-needed form of funding for game-changing innovation through the reauthorization of the Advanced Research Projects Agency for Energy, and directs the agency to help ensure that these promising technologies are shared with the private sector. This is roughly funded at $200 million.

Federal investments can be especially effective when the funds are combined with private sector investments. Just two weeks ago, the Chair of the Council of Economic Advisers, Christina Romer, testified before this Committee that $46 billion in public funding in the Recovery Act encouraged an additional $100 billion in investment by the private sector in projects related to clean energy.

I am especially pleased that my fellow New Yorker, Mr. Anthony Malkin, is here to testify about energy efficiency retrofits he is undertaking in one of our greatest cultural icons, the Empire State Building.

New lighting, windows, and heating and cooling systems reduce the amount of energy tenants use while improving the quality of their space.

I am eager to discuss with our panel how Congress can ensure that these needed investments in a clean energy economy will occur, leading us to a stronger economy with good jobs and a cleaner planet.

I welcome all of the panelists and I look forward to your testimony, and I recognize Mr. Campbell for five minutes.

[The prepared statement of Representative Maloney appears in the Submissions for the Record on page 38.]

OPENING STATEMENT OF THE HONORABLE JOHN CAMPBELL, A U.S. REPRESENTATIVE FROM CALIFORNIA

Representative Campbell. Thank you, Madam Chairman.

I was not actually going to make an opening statement, but in the absence of the Ranking Member right now, I will make just a couple of comments.

I believe it is true that certainly innovation and some forms of clean energy can add to economic growth and productivity, but only if those things increase productivity and are accretive to the economy.

So I do not think it is fair or correct to say that any clean energy development, or anything in this area, is going to add to economic growth. If we in fact promote forms of energy which cannot be baselined, and which can only be occasional uses of energy, and which are very expensive and actually either through government subsidies or otherwise require that the economy pay more for the same energy than it did before and still has to keep the baseline, I do not see how that is actually going to be providing any sustainable productivity or economic growth.

And, in fact, if you require the economy to pay more for something that they are already getting for less without some other accretive benefit, then I am not sure where that does anything but actually cost jobs and hurt the economy.

That being said, there are certainly plenty of areas of energy development—such as nuclear—where there have been tremendous advances in technology, where we can actually do it all, where we can actually create cleaner energy that is more domestically sourced, and that is as cheap or cheaper than the energy sources that we have today.

So I hope that when we as a government and as a society look at this, that we discriminate between those forms of energy that actually can accomplish the objective while creating economic growth and jobs, and not necessarily force ourselves to be dealing with those forms of energy that perhaps are not going to be as economically beneficial as others.

With that I will yield back.

Chair Maloney. Thank you very much. We are very pleased that Senator Bingaman is here. He is recognized for five minutes.

Senator Bingaman. Madam Chair, I have no opening statement. I am here to hear the witnesses. Thank you.

Chair Maloney. Would you like, Mr. Burgess?

OPENING STATEMENT OF THE HONORABLE MICHAEL C. BURGESS, M.D., A U.S. REPRESENTATIVE FROM TEXAS

Representative Burgess. I thank the Chairwoman for the recognition. I want to welcome our witnesses here today. I am certainly anxious to hear your testimony, Dr. Ward, a Texan. I am certainly grateful that you are on the panel. We know it will be an even-handed approach since there is a Texan in the group.

Promoting our economy and increasing energy resources are two of the most important issues facing our country today. Alone, these two issues are important, but when combined the increased energy resources will help revive our economy and in turn increase economic output, and ultimately the bottom line is, add jobs to the economy—which is the key issue right now.

I have personally spent a great deal of time focused on this in my home District in North Texas. We have terribly hot summers. Right now I think the projected heat index is well over 100 degrees. Two weeks ago I brought together experts in north Texas to discuss energy efficiency, and clean energy production for the future.

It is an annual event that I hold every summer, because regardless of which side of the discussion we find ourselves, whether it is from the standpoint of global warming, or the standpoint of national security, or we just worry that we are going to run out of oil one day, the common ground is energy efficiency. And no one—no one— wants to be in favor of wasting energy.

New technologies to reduce energy wastage will move us towards, say, an electrical automobile fleet. This was actually surprising for me, met with some degree of optimism in North Texas. You know, we love our trucks. We love our Dooley pickup trucks, but nevertheless people are willing to look at other alternatives, particularly for a vehicle that would primarily be involved in commuting.

The questions that I will have for the panel today are about the availability of clean energy sources and their costs. Achieving energy security and increasing renewable, less carbon-intensive energy sources are important to our country's energy discussion. However, there are important questions:

How can we promote clean energy sources like wind, energy, solar, and thermal, and other methods, without increasing consumer cost?

What is a realistic amount of clean energy to expect in the future? And what energy efficiencies can we achieve until more renewable sources are available?

My State of Texas is a leader in clean energy. In fact, if Texas were its own country—which some people have talked about—we would be the world leader in wind energy. And indeed, it was our clean energy governor, George W. Bush, in the mid-1990s who put the regulatory framework in place in Texas which has made Texas one of the largest producers of clean energy in the world.

The Barnett Shale is a huge reserve of natural gas and an alternative for tight shale formation in my district. It provides an economic boon, as well as a source for fuel for our economy. But it does pose specific challenges. Whether it's the oil industry encroaching upon civilization, or civilization encroaching upon the oil industry, it has led to some tension in my district, and the resource

must be developed in a sensible fashion which is sensitive to the fact that there are people now living nearby to the fields of production.

In 2009, Texas produced more megawatts of wind energy in the country—wind energy, and added more megawatts of this energy than any other state, but we also have the situation where we have to bring that energy to the place where the people live. And so the siting of new transmission lines becomes an issue in an area that has increased in population.

So with those above-mentioned sources accounting for such a small amount of energy consumption, how realistic is it for our government to rely on these sources for providing large numbers of employment in our country in helping our economy?

Encouraging the use of clean energy sources is a laudable goal. It cannot only revive our economy, but help boost it. But the discussion I hope to hear today is what are the realistic expectations for us to have in the short term? And what can Americans be doing to promote the expansion of clean energy use and energy efficiency to achieve what we need with existing resources?

Thank you, Madam Chairwoman. I will yield back the balance of my time.

Chair Maloney. Thank you very much.

Mr. Hinchey.

Representative Hinchey. Well, Madam Chairman, thank you very much. I don't have an opening remark, either, but I want to thank you very much for holding this session today. This subject is critically important, and it is something that we have to deal with.

As you know, we have already passed somewhat of a significant bill in the House of Representatives. It was not quite as strong as what some of us would like to have seen passed, but it is something that really needs to be done. And we certainly hope that before the end of this year, before the end of this Congress is over, that this legislation is going to be passed in the Senate, or something very much like it, so we can get some progress advanced here.

So this issue is critically important, and critically important in a variety of ways: the situation in the gulf of Mexico, and the circumstances of global warming. These are critically important issues that need to be addressed by this Congress. I am very anxious to hear what you have to say, and to engage in the interaction of questions and answers about these issues.

So, Madam Chairman, thank you very, very much.

Chair Maloney. Thank you. Mr. Brady.

OPENING STATEMENT OF THE HONORABLE KEVIN BRADY, A U.S. REPRESENTATIVE FROM TEXAS

Representative Brady. Well, Madam Chairman, I thank you for holding this hearing on energy matters at this time. And I welcome the panelists to what I hope will be a substantive discussion of energy supply and environmental issues.

I find the submitted testimony very encouraging in this regard. And, Dr. Ward, thank you for joining us as our guest.

To observe our Administration's energy decisions is to wonder whether it has any comprehension of the future energy supply challenges our country faces. The ill-conceived Gulf drilling moratorium flies in the face of everything common sense tells us about our precarious energy future and what we should be doing about it today.

The drilling moratorium is already killing good-paying American energy jobs, sending rigs overseas, and with them our workers, equipment, capital, and eventually America's traditional energy infrastructure.

Given the global nature of energy production, these rigs will not be returning any time soon. What is more, President Obama has not even responded to our invitation to travel to Houston, Texas, to meet face to face with the energy workers and small businesses whose livelihoods are at risk due to the moratorium.

Yet, the President will be traveling to Houston on August 9th to raise campaign cash for the Democratic Party. We have asked him for just an hour of his time, or maybe even just 15 minutes of his time to meet with our workers and businesses, but as of today, just silence from the White House.

Mr. President, can you spare any time at all for these Americans whose jobs you are killing and sending overseas? Where are your priorities?

Neither the White House nor Congress seems to understand that the current relative lull in energy demand results from a weak economy. It does not mean we have the luxury of halting large-scale energy projects and betting our future on small-scale alternatives that we all support but that are not yet ready to affordably meet America's energy needs.

The Gulf of Mexico accounts for 19 percent of the Nation's total proven oil reserves, and 30 percent of total U.S. production. Solar and wind technologies together account for less than 1 percent of the Nation's energy supply.

In 2008, the Gulf of Mexico's Outer Continental Shelf had the largest amount of new oil-field discoveries in the United States, which increased our proven reserves while oil reserves fell for the Nation as a whole.

By all means, let's help renewable energy develop its full potential. But let's not foolishly thwart the growth potential of our established energy industry which provides the affordable bridge to America's green future.

After 50,000 wells have been drilled in the Gulf's Federal Outer Continental Shelf, and nearly 4,000 in deep water without a substantial spill, how can anyone jump to the conclusion that the BP accident points to an imminent systemic threat, and then shut off all deep-water drilling?

And who would bet America's economy on subsidized wind and sun energy when there are private companies investing billions of dollars to develop deep-water oil and gas reserves off our shores?

Does this make any sense? And where is the cost/benefit analysis? A recent study by IHS Global Insight found last week that if policies were adopted by Congress or the White House that effectively prevent independent oil companies from participating in future Gulf offshore development, the employment loss would reach

300,000 American jobs, and the loss of local, state, and federal revenues would total $147 billion in losses over the next decade.

And that is because independent energy producers hold majority interests in 81 percent of all producing leases in the Gulf of Mexico, nearly half of those in the deep water. This week, rather than the House of Representatives hastily rushing through legislation with far-reaching impacts on jobs, energy prices, and energy security, it would be much wiser to bring together science, industry, and government in partnership to develop a thoughtful, safe, and prosperous path forward to Gulf exploration and development.

Our National economy, already suffering with 9.5 percent unemployment in a subpar recovery, cannot be harmed further with the devastating drilling moratorium and hasty legislation that kills jobs and makes us even more dependent on foreign oil.

Madam Chairman, I will submit the rest of my statement for the record, but we look forward to the discussion today on the path forward. Thank you.

[The prepared statement of Representative Brady appears in the Submissions for the Record on page 41.]

Chair Maloney. Thank you. Thank you very much. Senator Bingaman has informed me that he must leave shortly, but he particularly wanted to hear the testimony of Mr. Malkin, who has been a leader in existing building energy efficiency retrofits. I do want to call on Mr. Malkin first to speak while the Senator is here so he can hear him.

Mr. Malkin is coordinating the team that is in the process of retrofitting the Empire State Building, upgrading and restoring it, and making it more energy efficient, and he is the President of Malkin Holdings.

Mr. Malkin, you are recognized for five minutes.

STATEMENT OF MR. ANTHONY E. MALKIN, PRESIDENT, MALKIN HOLDINGS, NEW YORK, NEW YORK

Mr. Malkin. Thank you very much.

My name is Anthony E. Malkin. I am the President of Malkin Holdings, and I run the Empire State Building. Seated behind me are Empire State Building team leaders Paul Rode of Johnson Controls and Dana Schneider of Jones Lang LaSalle. Other members in our work are the Clinton Climate Initiative and the Rocky Mountain Institute. Duane Desiderio of the Real Estate Roundtable, of which I am a member, is also present behind me.

At the Empire State Building, we created the first replicable, nonproprietary, open source, quantitative process to give transparent economic justification to energy efficiency retrofits in the existing built environment.

Our work is guaranteed by the balance sheet of Johnson Controls to reduce our watt and BTU consumption by 38.4 percent. Our contract only guarantees 90 percent of our projected savings, so our actual savings will be in excess of 40 percent. Our payback period is three years.

It is estimated that, in American cities, 85 to 95 percent of all buildings that will be here in 2035 are here today. Building new and efficiently will not move the needle on energy consumption.

Only addressing the existing built environment will make a difference.

Let's use New York City as an example: 80 percent of the energy consumed is consumed by buildings; 20 percent of the buildings consume 80 percent of energy consumed by buildings. Therefore, 64 percent of all energy consumed in New York City is consumed by 20 percent of the buildings.

If the 20 percent of buildings in New York City that consumes 64 percent of all energy deployed our program to the same effect, total energy consumption in New York City will be reduced by 25 percent. In the process, many jobs are created, skills are taught, and local economies are stimulated.

That is the equivalent of creating surplus power through alternative generation right in the middle of New York City, carbon free. But generating our savings is 3 to 5 times per watt less expensive than alternative energy generation by wind, solar, or geothermal. Until the cost of a watt of alternative energy generation equals the cost of a watt of savings, we must focus on savings. You get the same carbon reduction with better economics and no additional infrastructure cost.

Creating this excess power allows for a number of options:

Shut down the sources of power;

Create carbon credits for trading; and/or

Reduce the size of investment in the smart grid for distribution of new sources of power.

What can government do?

Treat the reduction of the consumption of energy, treat that reduction as the production of energy through alternative, low-carbon output sources.

Allow for the sale of tax credits, accelerated depreciation, and expensing of capital expenditure to help fund and reduce the net cost of such work.

These financial incentives will encourage building owners to make investments that address broad, intelligent policy objectives.

Focus on the big energy consumers first. The Empire State Building consumes the equivalent of 40,000 single-family homes in energy. The focus on the community model for creating residential energy savings has been misplaced. Focus on the big energy consumers with big systems to effect fast and rewarding change.

Develop national standards for energy consumption reporting. To understand energy consumption, we must share consumption data. Individual cities and states are already approaching this issue independently. We need one set of standards rather than a series of conflicting standards.

Change EnergyStar from a database of relative measurement to a reporting and rating program based on actual consumption data. Empire State Building has earned an EnergyStar rating of 90, with only half our work completed. That means we are more energy efficient than 90 percent of comparable buildings of any age. But EnergyStar is only a relative rating system which does not provide a return on investment measurement or argument.

Understand limitations. We need a framework which recognizes realities and differences by building types, system, uses, and geographical locations. Allow for life cycle analysis instead of wasteful

edicts. Inform your policy with our practice. Significant savings are within tenant-controlled spaces, and legislation cannot merely impose on landlords but must address users as well.

Reward successes and encourage first movers. The real estate industry is inherently competitive. Owners and lenders who are early movers should be rewarded. This will differentiate them and encourage others to catch up and contribute to the health of the real estate industry.

We are the future. We are not motivated by "doing the right thing," but by making money. I look forward to answering your questions and finding ways in which the Empire State Building can inform government policy with the practices we have developed.

I encourage you to visit our website: esbsustainability.com, and come see the $2 million installation we just unveiled yesterday in our observatory, which is viewed by 4 million people a year from this point forward, all about the process we have created and its broad impacts.

Thank you, very much.

[The prepared statement of Mr. Anthony E. Malkin appears in the Submissions for the Record on page 43.]

Chair Maloney. Thank you very much. I would now like to introduce another distinguished witness, Dr. Michael Greenstone. He is the 3M Professor of Environmental Economics at MIT, and he is also a Senior Fellow in Economic Studies and Director of the Hamilton Project at the Brookings Institute. Previously he served as Chief Economist for the President's Council of Economic Advisers under President Obama.

Welcome, Dr. Greenstone. You're recognized for five minutes.

STATEMENT OF DR. MICHAEL GREENSTONE, 3M PROFESSOR OF ENVIRONMENTAL ECONOMICS, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MA; DIRECTOR, THE HAMILTON PROJECT, THE BROOKINGS INSTITUTION, WASHINGTON, DC

Dr. Greenstone. Thank you, Chair Maloney, and Members of the Committee, for inviting me to testify today.

I am grateful for the opportunity to speak about two challenges that our country faces: the stagnation in economic opportunity and the risk posed by our continued reliance on fossil fuels.

The key purpose of my testimony is to discuss how energy research and development, or R&D, can enable us to begin to confront these dual challenges.

Even before the Great Recession's arrival, there were legitimate concerns about U.S. competitiveness. Between 1979 and 2007, real earnings for high school graduates with no further education declined by 12 percent. Earnings for high school dropouts declined by 16 percent over the same period.

Further, between 1990 and 2005, our world market share of high-tech exports dropped from 20 percent to 12 percent, while China's more than doubled, rising to 19 percent. At the same time, our need for access to reliable and affordable petroleum constrains our foreign policy objectives, especially our national security ones. This is the essence of our energy security challenge.

Further, climate scientists tell us that warming in the climate is unequivocal and very likely due to burning of fossil fuels such as petroleum. The global consequences of climate change for health and economic growth are projected to be quite negative.

Two interrelated factors increase the odds of such dramatic changes in temperature will occur. First, fossil fuels like coal and petroleum are the cheapest sources of energy available today and are likely to remain inexpensive in the future relative to alternative sources of energy.

Second, due to their low levels of income, developing economies will continue to pursue cheap energy sources in the coming decades.

Our nation needs a new solution to these dual challenges of U.S. competitiveness and fossil fuel dependence. I believe a new program of energy R&D should be part of it. Such a program offers the prospect of innovation that will produce industries of the future and good jobs for our nation.

Why is R&D so important? Our economic progress is driven by invention and application of new technologies. And R&D spending develops and drives these new technologies. However, the private sector rightly focuses on applied projects where the payoff is likely to accrue only to them.

In contrast, government can sponsor the kind of basic research projects that seek wide-ranging scientific understanding, and these basic research projects can affect entire industries rather than individual firms.

Two of the most notable vehicles for supporting R&D in the United States are the National Institutes of Health, the NIH, and the National Science Foundation, the NSF.

NIH-funded scientists have won over 93 Nobel Prizes, and 15 of the 21 most important new drugs discovered between 1965 and 1992 were developed using NIH-funded research. NSF-funded basic research has produced meaningful advances, including bar codes, Doppler Radar, and web browsers. These advances have created entirely new industries that have helped to make us a world leader.

In contrast, funding for energy research has often been focused on the deployment of existing technologies, rather than the development of new ones. Deployment is a task that is better left to the private sector.

Further, energy research funding decisions have not been as single-mindedly based on peer review in contrast with the approach that prevails at the NIH and NSF.

How much does the United States currently spend on R&D? As the chart shows, the Federal Government's contribution to R&D spending as a share of GDP has been declining over the last several decades, from its Cold War peak of about 2 percent, or more than 2 percent, to less than 1 percent today.

The next chart depicts the time series of federal R&D in the energy sector. In 2009, federal R&D spending on energy totalled just $1.7 billion, or a little more than 1/100ths of 1 percentage point of GDP.

Let me put this in some context. That $1.7 billion figure is just 55 percent of the $3.1 billion that we currently spend on subsidizing employee parking through the Tax Code.

It is also instructive to compare U.S. spending with other countries. Our rate of energy R&D spending puts the United States in last place among the 12 OECD countries that spent the most between 2004 and 2008.

The Hamilton Project—so let me conclude. The Hamilton Project, an Economic Policy Group at Brookings that I direct, is commissioning a series of discussion papers on ways to improve the Nation's R&D program, and we will unveil them in 2011.

In the meantime, I would like to suggest five broad principles for reforming energy R&D policy:

Number one, federal energy R&D funding should be increased substantially from its woefully inadequate current levels.

Two, energy R&D funding should follow the NIH and NSF's model and be free of political influence.

Three, federal R&D funding should be focused on basic research not applied research or deployment.

Four, the use of innovative funding mechanisms such as prizes should be given consideration.

And number five, energy R&D should include funding for projects to demonstrate that new technologies can be implemented on a commercial scale.

Let me conclude. In pursuing a new energy R&D program, there are difficult political issues that must be confronted. Perhaps chief among them is the identification of a source of enhanced funding in this tight budget environment.

At the same time, we cannot stick with the status quo. It is imperative that we begin to confront the issues of competitiveness and fossil fuel dependence that have hampered our progress over the last several decades.

Thank you very much for the opportunity to testify before you today. I would be happy to answer any questions that you may have.

[The prepared statement of Dr. Michael Greenstone appears in the Submissions for the Record on page 83.]

Chair Maloney. Thank you very much. And I would now like to introduce Dr. E.G. Ward. He is the Associate Director of the Offshore Technology Research Center at Texas A&M University. His responsibilities include planning, coordinating, and administering of the OTRC research program to meet industry and government technical needs in areas associated with deep-water offshore oil and gas development. Prior to joining Texas A&M, he worked for Shell Oil Company managing the design of Shell's deep-water structures, and conducting research in ocean engineering.

I would like to welcome all of you, and I would like to call on Mr. Brady to begin the questioning after Dr. Ward's testimony.

STATEMENT OF E. G. (SKIP) WARD, PH.D., ASSOCIATE DIRECTOR, OFFSHORE TECHNOLOGY RESEARCH CENTER, TEXAS A&M UNIVERSITY, COLLEGE STATION, TEXAS

Dr. Ward. Thank you, Madam Chairman.

It is indeed an honor and a privilege to be able to address you all this morning. I appreciate the opportunity.

I think we would all agree that a robust drilling program must continue to maintain and increase our domestic oil production for America's continuing energy needs, even while alternative energy sources are being developed for our future.

Many consider the moratorium to be a six-month long period during which the Macondo well disaster will be studied, safety practices and regulations will be modified and improved, decisions regarding cleanup and mitigation and containment issues will be addressed, and then the drilling and production will go back to the same levels as before the disaster.

However, in the face of the six-month moratorium and the uncertainties as to when drilling can actually resume, and under what conditions and circumstances and regulations, drilling rigs are beginning to leave the Gulf of Mexico. Two rigs have already announced their departure, and I expect there will be more.

What I would like to address this morning is the aspect of the moratorium that has not been considered to date, and that is the impact on longer term Gulf of Mexico production as rigs leave as a result of the moratorium.

I will focus on oil, but my remarks are equally applicable to offshore natural gas production.

Consider two factors. When a rig leaves the Gulf of Mexico to work overseas, it will not do so on a six-month contract. It will go to Angola, Brazil, or some other place probably on a two- to five-year contract. So the effective time when these rigs are not drilling in the Gulf of Mexico, exploring, producing, maintaining ongoing production will be two to five years, not six months from the moratorium.

The second thing to consider is that the production rate from an oil well begins to decline as soon as it starts to produce. Reservoir management is undertaken to help slow this decline, but it is inevitable and eventually the reservoir is depleted, no more economic production can be sustained, and new reservoirs must be found and produced to keep the oil flow going.

So let's ask how fast the Gulf of Mexico wells decline. The MMS has derived estimates based on their study of historical production in the Gulf that the decline rate is on the order of 12 or 13 percent per year. This figure does include ongoing maintenance drilling. And so for a no-drilling case, which I would like to pursue, I am going to assume the effective rate is actually about 15 percent.

Others have estimated that the actual decline rate is much higher than even that, at 20 to 30 percent. I will use 15 percent and I've shown in my testimony some sensitivity cases for up to 20 percent.

So let's look at the case where the moratorium results in all rigs leaving the Gulf or being unable to drill for a two-year period. What's the impact on production?

In 2010 before the moratorium, the Gulf of Mexico produced 1.6 million barrels of oil a day. That is 585 million barrels a year.

By the end of 2012, assuming that no drilling occurs in the two years till then, the production would drop to about 1.1 million barrels a day—a 30 percent reduction.

In that two-year period (2011–2012), 450 million barrels of oil would have to be imported just to make up for this production that was lost. The import value at $70 a barrel would be over $30 billion. There would be 1,500 additional shuttle tanker transits in the Gulf required to bring that imported oil into the Gulf, creating further oil spill hazards.

And finally, when the rigs returned in late 2012, what would it take to get production back from the then-1.1 million barrels of oil a day to the 2010 value of 1.6 million barrels a day that existed before the moratorium?

A very large Gulf of Mexico oil and gas production can produce up to 200 thousand barrels of oil per day. So would it take three of these major productions to get us back to where we are today? No. It would take about four years to bring those projects online. And during that period, the production rate would drop another half a billion 500 thousand barrels per daydollars a year, so it would take five very large projects to catch up to where we were in 2010.

So the six month moratorium really has the potential to cause lasting impacts to our ability to produce oil.

Let me sum up. No one knows how many rigs will leave and for how long, but the potential production decline that could result from the moratorium can have long-lasting impacts on our domestic production.

There are many negative impacts of the moratorium that have been discussed elsewhere, including unemployment, new safety concerns, economic losses for both industry and governments, and increased dependence on foreign oil.

However, much has been learned from the Macondo disaster to date, and these lessons learned, plus the recommendations that were included in Secretary Salazar's report to the President that are now being implemented in Notices to Lessees, and the oil spill containment system that industry has recently announced, provide a strong basis to allow drilling to resume now while continuing to further improve safety against these very rare events.

Chair Maloney. The gentleman's time has expired. Could you wind it up?

Dr. Ward. I have finished. Thank you.

[The prepared statement of Dr. E. G. (Skip) Ward appears in the Submissions for the Record on page 94.]

Chair Maloney. Thank you very much. But one way we can produce more energy is by preserving more. I was impressed really by your statement, Mr. Malkin, that you were bringing down the Empire State Building's energy consumption by over 40 percent. That is a very impressive accomplishment with not only financial savings to the building, but also improving the environmental benefits for others, and also freeing more energy for other uses.

Can you elaborate more on what you are working to accomplish? And how can we get other owners of commercial buildings to follow the same type of lead that you are taking in New York? And what does this mean for energy in terms of New York City if other large buildings would follow your lead and conserve that much energy, releasing it for other uses? Can you elaborate how we can get more buildings involved, and the benefits to energy saving overall?

Mr. Malkin. Yes. Thank you. First of all, I would like to just restate the facts which I had said earlier to make sure they set in. I wanted to get in within my five minutes, but literally according to the Mayor's Office of Long-Term Planning in New York City, 20 percent of the buildings in New York City consume 64 percent of all of the energy consumed in New York City. That includes railroads, buses, subways, taxis, all energy.

So a 40 percent reduction in watts and Btu consumption by those 20 percent of buildings would in fact be the equivalent of generating 25 percent of all of the power consumed in New York City right in the middle of New York City.

New York City is particularly energy dense. So the reality is, in a city like Phoenix, it's probably more—and if you look at Phoenix as an SMSA, as opposed to just the city proper, it's probably more about 60 to 65 percent. But even in small towns in America, the majority of all energy consumed is consumed in buildings. That's point one.

Point two, this is the first quantitative approach ever developed. And that was the groundbreaking work which we started with Johnson Controls, Jones Lange LaSalle, and the Rocky Mountain Institute, in an airplane hangar in Eagle, Colorado, back in 2007.

There has been no quantitative approach up to this time, and we did launch and announce it in April of 2009. But when we launched it in April of 2009, it was with a contract signing for work which we had already done in private and in secret. We did it in private and in secret because we were afraid that one of the outcomes might be that we would prove you could not have an economic justification for energy efficiency retrofits, and it would only be possible through regulation and additional expenditure without economic result.

There are other people already copying what we are doing, strictly from an economic perspective. As I mentioned to you in confidence, there will be a large 2-million-square-foot building in New York which will make the announcement that it is already well underway with this project in September of this year. There are two large corporate headquarters in New York where this work is preliminarily underway.

And the key, I believe, is to look at the real estate industry, a very large and vibrant and job-creating industry in America, as a source of electricity, as a source of power, as opposed to just a consumer. And, to try to coordinate the efforts of the real estate industry with appropriate government incentive and interaction, and legislation, to band together and produce this power in an organized fashion by focusing on, first of all, commercial applications. We consume 40,000 households' worth of energy at the Empire State Building.

The same two people behind me would be responsible for doing four or five single-family homes. Instead, they are responsible for doing the Empire State Building. So concentrate on the big energy consumers, number one.

Number two, really one should look at the same sort of tax credits and tax benefits which oil and gas drilling, wind, solar, and geothermal have always enjoyed as energy producers. But put some of

that money into energy conservation. That is a very good source of financing for this sort of work.

The third thing I would say is, you have to create openness and sharing of energy consumption data. Real estate people love attention and hate scrutiny. Everything that we are doing is wide open for scrutiny. And we are hoping to create a competitive atmosphere—we are succeeding in creating a competitive atmosphere amongst brokers and tenants who are choosing to come to us because we are helping them with their own objectives of controlling costs. Salaries, rent, and utilities are the three highest costs of businesses in America. We are working on that third one.

Chair Maloney. Thank you very much. My time has expired. Mr. Brady.

Representative Brady. Well thank you to the panel. Mr. Malkin, your testimony is impressive. I know commercial buildings have dramatically increased their energy efficiency over the last several decades, but you bring a perspective on the cost/benefit analysis that is very, very helpful.

Dr. Greenstone, thanks for making the point on the need for R&D. If you could—I didn't find it in your testimony, but if you have any information comparing federal R&D spending versus private-sector R&D spending, especially in renewable that would be helpful. I find a number of companies are doing research that people are not even aware of that is creating, I think, some hope for us moving forward. Any information you have along that line would be very helpful.

And, Dr. Ward, your point about what happens with this drilling moratorium in the here-and-now, clearly we have two rigs that already announced they are going to Egypt and the Congo. Many more rigs are contemplating leaving and will not return any time soon.

Each rig takes with it at least 1,000 to 1,500 American jobs. And then the vendors and suppliers who supply those rigs are hurt. And your point is, if I read it right, is that along with those losing rigs, and jobs, and equipment, and our American businesses, that we end up, in fact, importing more oil by more risky means of transmission than receiving it from the Gulf today. And, that the Gulf also is sort of the buffer to OPEC, that the amount of oil it produces keeps us from being held hostage to foreign countries that can drive up prices and really cripple our U.S. economy.

Can you go back to the point you made? What is—how much less oil will we be producing? Not counting natural gas, which is again I think the best bridge to an affordable green energy future for America, it really is the backstop for wind and solar and other renewables and allows them to grow and yet keep reliability, but what is the production? How much less energy will we be producing in the United States if this very poorly thought of moratorium continues?

Dr. Ward. If the moratorium results in rigs leaving for two years, the reduction in the Gulf of Mexico will decline by 450 million barrels a year.

Representative Brady. And that's what percent? That's about——

Dr. Ward. About 30 percent of the Gulf production.

Representative Brady [continuing]. So we will lose a third of our most critical portion of oil development?

Dr. Ward. That's correct.

Representative Brady. And if it goes longer, it is how much?

Dr. Ward. If it goes longer, the 450 I believe goes up to about over a billion barrels of oil in five years.

Representative Brady. So we would lose, at that point, two-thirds of our production.

Dr. Ward. Correct.

Representative Brady. You were invited by the Interior Department to peer-review their original drilling moratorium——

Dr. Ward. Not to review, but to contribute to the report.

Representative Brady [continuing]. Contribute to it. You made a number of safety suggestions, but you and a number of others in that group did not support the drilling moratorium, saying it would not make the Gulf safer, and would have a dramatic economic impact.

Can you——

Dr. Ward. That's correct.

Representative Brady [continuing]. Can you talk about that a moment?

Dr. Ward. Yes. There were a number of safety recommendations that dealt principally with procedures, both from the standpoint of planning wells, executing wells, the regulatory environment that would give more scrutiny to ongoing wells. I think it is pretty generally recognized that the procedures and design of the BP well are not ones that are practiced by the wide majority of industry.

And I think the rarity of blowouts, as disastrous as they are, certainly belie that point.

Representative Brady. Coming from the university setting, as an academic one of the points that you made then and made today in your testimony is that stopping the production here in the U.S. does not make the shore safer by increasing——

Dr. Ward. The imports.

Representative Brady [continuing]. The imports.

Dr. Ward. Right.

Representative Brady. And using the tankers. You have actually increased the risk of oil spills in the Gulf.

Dr. Ward. Of near-shore oil spills in particular, yes.

Representative Brady. Is there any other point about your testimony? I know we always keep a strict five-minute rule. Any other point you wanted to make today on the impact on jobs or pricing in the future?

Dr. Ward. Well certainly one only has to look at recent hurricane interruptions in production between 2004 and 2008 to see the rapid and significant price increase that occurs when oil is curtailed in the Gulf of Mexico. So I think it is a fairly rapid response.

Representative Brady. All right, thank you, Dr. Ward, and thanks for traveling here today.

Dr. Ward. Thank you.

Chair Maloney. Thank you. Mr. Hinchey.

Representative Hinchey. Dr. Greenstone had a comment.

Chair Maloney. Yes, excuse me.

Dr. Greenstone. I just wanted to comment on this last point about the impact of the moratorium on prices. I looked this up in the U.S. Energy Information Administration Report, and according to them by September the moratorium will have contributed to a 1/100th of 1 percentage point reduction in global petroleum production. And I think, as difficult a political decision as it is to have a moratorium, and I think there are good arguments on both sides, I think the notion that it would somehow affect global prices for petroleum I think is not well founded.

Representative Brady. I guess we will see where that goes, huh?

Chair Maloney. Thank you. Mr. Hinchey.

Representative Hinchey. Madam Chairman, thanks very much for this hearing. And thank you, gentlemen, for everything that you have said. We really need to be dealing with this issue much more effectively.

Mr. Malkin, I thank you very much for all the talk that you gave about energy efficiency. I am delighted to hear that the City of New York is doing the kinds of things that you talk about. That is very positive. Very progressive. And it is going to make a big difference.

Twenty percent of the buildings are using up more than 40 percent of the energy there? That's something——

Mr. Malkin. 20 percent are using 64 percent.

Representative Hinchey [continuing]. 64 percent—20 percent using 64 percent. That is absolutely shocking. And it is something that really needs to be overcome. And I am sure it is not unique. It is probably the same in every city all across the country and a lot of other places all around the world. So energy efficiency is critically important.

The whole system that we have to deal with also is the bringing about of the practical use of energy effectiveness in other ways. One of the most effective things that we could do, it seems to me, would be utilizing solar energy. We have more energy coming out of the sun every single day all around this planet, much more than is used right now.

So this is something that really needs to be dealt with. We are paying much too much attention to oil and gas and the standard forms of energy. One of the things we have here is $18 billion that we spend in subsidies for the oil and gas industry in the United States every single year.

If we were to take half of that, just take half of that away from them and put it into energy research and development, we would be doing something that would be very, very significant. So I would appreciate it if we could talk a little bit about that and how it needs to be done.

Dr. Greenstone, one of the things that you really surprised me with was the fact that almost a dozen countries around the world are engaged in more research and development in the energy operations in those countries than here in the United States—simple countries like South Korea, Finland, France, Spain, Italy, Canada, Germany, Sweden, Mexico, the Netherlands, and of course Japan, the most. And China is not included in that, but China is doing an awful lot, and they are doing it in different ways.

So I think the main issue that we should be dealing with is alternative energy. And the main form of alternative energy is solar energy. Yes, there's wind energy. There's a whole lot of things that can be done positively with that. Countries like the Netherlands are generating huge amounts of energy through wind forms, and there are some other countries that are engaged in that as well.

But what would you suggest that we do with regard to the development of solar energy, that simple form of energy that flows down on this planet every single day—huge, huge amounts of energy, much more than we are ever using? Why aren't we doing it?

I mean, this government frankly, as you pointed out, beginning in, when was it, something around 1980 I think, was it, that sharp decline in the use of——

Dr. Greenstone. In the early '80s, yes.

Representative Hinchey [continuing]. The early '80s. Well, maybe you could talk a little bit about that and tell us what we need to be doing, and how we should be doing it more effectively.

Dr. Greenstone, if you would start?

Dr. Greenstone. Yes, I think, Congressman Hinchey, these are excellent comments you made and I just want to try and amplify a few of them.

I think the basic problem is that fossil fuels—fossil fuel, petroleum and coal, remain the cheapest source of energy that we have right now. And until we undertake a serious program of research and development, that will remain to be the case.

And so to your point, the sun is a wonderful source of energy. And I think if we devoted the kind of substantial increase in funding for research and development into solar energy, that could well cause solar to be cost competitive with the fossil fuels that are the source of both our energy security and our climate problems.

Representative Hinchey. Mr. Malkin.

Mr. Malkin. I sit before you importantly as a capitalist. We invest in the oil and gas business. We have owned refineries. We're—I'm also relatively green, as it were, looking forward.

We've got to deal with the national priorities of this country, and we've got to deal with energy independence. Solar has a role. Solar is still three to five times as expensive as energy savings. So my thinking is, we've invested in solar as well and done very well on that. But my thought is there's a mix here. There's a cocktail that's required: conservation, maintaining baseload, and bringing on the alternatives.

There's got to be the correct mix. So I think that there are good policies in place for solar right now, and there are big leaps being made. The biggest and most important thing you could do to sustain the development for solar, the technological development, is maintain a consistent and straightforward and understood set of programs in the U.S. Federal Government that extend over a five-year period, not a one- to two-year period, so that people can justify long-term planning and capital expenditure.

The exact same thing for energy conservation. The same way the oil industry and gas industry has benefitted for so long because of the knowledge that these programs and policies and subsidies were in place and could be relied upon when you're making long-term capital expenditure decisions. The big projects in the Southwest for

solar that will be coming are very large. They're billion dollar projects. They need to have a firm regulatory framework underfoot.

Chair Maloney. The gentleman's time has expired. Mr. Brady is recognized for the purpose of a request.

Representative Brady. Thank you, Madam Chairman. I would seek unanimous consent to have Senator DeMint submit questions for the record.

Chair Maloney. No objection.

Representative Brady. Thank you.

[Questions dated July 27, 2010 from Senator Jim DeMint to Dr. Michael Greenstone appear in the Submissions for the Record on page 103.]

[Question dated July 27, 2010 from Senator Jim DeMint to Mr. Anthony E. Malkin appears in the Submissions for the Record on page 105.]

[Questions dated July 27, 2010 from Senator Jim DeMint to Dr. E. G. (Skip) Ward appear in the Submissions for the Record on page 106.]

[Document dated August 27, 2010 transmitting Dr. Michael Greenstone's responses to Senator Jim DeMint appears in the Submissions for the Record on page 107.]

[Document dated August 11, 2010 transmitting Mr. Anthony E. Malkin's response to Senator Jim DeMint appears in the Submissions for the Record on page 110.]

[Document dated August 16, 2010 transmitting Dr. E. G. (Skip) Ward's responses to Senator Jim DeMint appears in the Submissions for the Record on page 111.]

Chair Maloney. Mr. Campbell.

Representative Campbell. Thank you, Madam Chair.

I am going to try and ask each one of the three of you in the order in which you said something.

Mr. Malkin, I think I heard you say that your technology in the Empire State Building in New York is producing a payback in three years?

Mr. Malkin. Yes.

Representative Campbell. That is phenomenal from any——

Mr. Malkin. It is phenomenal, and it is documented.

Representative Campbell [continuing]. So really you don't need an incentive, or a subsidy, or whatever, for that kind of payback. Won't the private sector just jump all over that?

Mr. Malkin. You know, I wonder how many oil industry investments would be made if they had to do it on their own without some form of subsidy on just a three-year—I would suggest that, and having been in the industry I can tell you, we—a little quicker than that.

But I would tell you that——

Representative Campbell. I understand you would like it because you could sell more, with a two-year payback, I get that.

Mr. Malkin [continuing]. The important thing is—by the way, this is nonproprietary. We do not own it. We created this in partnership with a bunch of other organizations. It is absolutely free. It is open source. You don't have to deal with any particular products.

I would suggest as follows: For an even playing field that you should look at energy conservation just as another form of energy. And put that into the mix. That is really my thought. I don't look at it as a panacea, but I certainly look at it as a giant force of change once it has been quantitatively organized.

Representative Campbell. And I am from Southern California, so I am sure in a more temperate climate that payback is not going to be quite the same.

Mr. Malkin. No, actually it will be different because it will be different steps. There are 67 different energy efficiency measures which we looked at iteratively. We chose 8 at the Empire State Building. They will differ by virtue of climate, building type, building use.

Representative Campbell. Okay.

Mr. Malkin. And it is all on a relative basis. You may in fact find that the savings that you would find have nothing to do with heating, but have more to do with air conditioning, have more to do with lighting, but the important thing is there is a variety.

Representative Campbell. Okay, fair enough.

Dr. Greenstone, the thing about research, I have spent most of my career in the car business and I was involved with the General Motors electric car back in the '90s, and I can tell you everyone, by now, thought there would be a breakthrough in battery technology, and it has not come in spite of billions of dollars of research both from the government, both under President Clinton and President Bush, and in the private sector.

So the research, I think you would agree, does not guarantee obviously a breakthrough. So what I wanted to ask you is, if we were to have a substantial increase in energy research done by the government, what would you charge them with doing? What would you ask them? What would you tell them to look into? Where do you think the breakthrough is closest, or the most practical, or the area in which we could get the most productivity?

Dr. Greenstone. Thanks for the question, Congressman Campbell. As you rightly point out, research does not have guarantees. It proceeds in fits and starts. I do not think when the NSF was funding what became web browsers anyone had in mind that it would produce web browsers, and the myriad industries and very high-paying jobs that have fallen out of that.

I think what we will have to do is convene a panel of experts, as is done at the NIH and NSF, who are only concerned with advancement of knowledge, and not concerned—and free of political influence—and try and focus research on where the highest returns are. And I think they could be given the charge of trying to find the lowest cost, low carbon source of energy and/or ways to sequester carbon.

You know, I would give a broad mandate and keep an eye on costs and kind of let science proceed as best it can.

Representative Campbell. Okay.

Dr. Greenstone. I also wanted to respond to one thing that came up in your excellent question of Mr. Malkin. I completely agree that for too long our energy policy has been focused on providing subsidies for deployment of particular technologies, be they oil——

Representative Campbell. Dr. Ward, what I want to ask you is, your focus has been obviously on the drilling and so forth in the Gulf, and again coming from the car industry as I have, there's 130 million vehicles on the road in the United States now that run—virtually all of them run on some form of refined petroleum product.

Even most of the new technologies that are out there, if everybody goes to a plug-in electric five or six years from now, those plug-in electrics will largely run on a refined petroleum product. Even if we went to fuel cells, the most practical use of the fuel cell runs on a refined petroleum product.

So my point is simply that we are going to—no matter what we develop for a long period of time, 10, 20, 30 years, we are going to need a lot of refined petroleum in this country under almost any scenario, are we not?

Dr. Ward. Yes, that is true.

Representative Campbell. And developing that domestically would be better than importing it?

Dr. Ward. Right. As Congressman Brady said, that is the bridge to these future energy alternatives.

Chair Maloney. The gentleman's time has expired.

Mr. Cummings.

Representative Cummings. Thank you very much.

I was listening to you all's testimony and, Mr. Malkin, I too am impressed with what you have said about your work in New York. As I was sitting here, I was just thinking that, you know, in a City like Baltimore where I am from, many cities are cash-strapped today and they are trying to figure out ways to save money.

I am just curious. How do you see that playing like, for example, the things that you do, with government buildings and buildings that are run by cities? I mean, that is maybe a way to knock out two birds, at least two birds, with one stone: save money and at the same time save energy? I was just wondering.

Mr. Malkin. Absolutely. We have actually had the City of San Francisco and the City of Philadelphia, in particular, and the City of London come and visit us at the Empire State Building so they can look at what we are doing and incorporate it into not only their buildings themselves but into the policies in the building codes which govern what happens in their cities.

There is no question that you will get two benefits. Every city has a capital-expenditure-based program. Every city is constantly reinvesting in its capital, and largely buildings are a big part of that.

So there is a big opportunity to combine these expenditures with integrated energy efficiency retrofits. The incremental cost is tiny, and the paybacks are very significant. And I think it would be very beneficial.

Representative Cummings. And long-lasting.

Mr. Malkin. Once you get your payback, that savings continues forever. I would like to just point out, by the way, that coal, nuclear, gas, and hydro are really the sources for the grid, not oil. Oil is really a transportation fuel. So my Tesla is powered off of the grid, and not by petrochemicals.

Representative Cummings. Dr. Greenstone, one of the things that you talk about in your testimony is how addressing this whole energy situation can—or not addressing it—affects infant mortality and all kinds of other problems. We just got a report in Maryland where African American babies, their infant mortality rate is going up; Whites are coming down. We just got that in yesterday. Could you talk about that a little bit?

Dr. Greenstone. Thanks for the question, Congressman Cummings.

In some research I've shown that very hot days increase the rate of infant mortality. So to the extent our continued reliance on fossil fuels will continue—will produce more and more hot days, that will lead to higher rates of infant mortality. And I think it underscores that we have been baking into the system through our reliance on fossil fuels changes in climate that are going to disrupt the way we live and impose economic costs both through health costs that you've outlined, and reduced agricultural yields, and a series of other negative changes in our environment.

And if we do not undertake changes in our reliance on fossil fuels, we are going to be subjecting ourselves to those costs.

Representative Cummings. And how would you say we should ensure that say, for example, jobs produced by a clean energy economy are American jobs and not just another industry that moves overseas? I mean we've got a lot of people out of work. And one of the things that I am doing in my District on August 7th is, we are bringing in young people who have either dropped out of school, or are trying to figure out where to go, and trying to direct them into areas like—first of all, getting their GEDs, and trying to get them into community colleges—but we are also trying to tell them where the jobs are going to be.

These are young people and we want to get them into some kind of careers. It would be a shame if we produce these energy-reducing jobs, and then they just get shipped overseas because I am trying to figure out where these people are going to work.

Dr. Greenstone. So there is no question, Mr. Congressman, that there is an international competition for jobs. We are seeing that every day. And one thing that, you know, decades of economic research have shown is that where ideas are created, there is stickiness. And so to the——

Representative Cummings. There's whatness?

Dr. Greenstone [continuing]. Stickiness. And so let me elaborate on that. So to the extent that we can fund a program of basic R&D that produces new ideas and new industries, while some of those jobs in those industries will go overseas, many of them will stay behind in the United States.

And that is I think the strongest part of the argument for the need for a clean energy revolution to further our economic competitiveness.

Representative Cummings. Thank you, Madam Chair.

Chair Maloney. Thank you. And Mr. Burgess.

Representative Burgess. I want to thank the Chair for the recognition.

Mr. Malkin, your story is nothing short of fascinating. As I mentioned, I do an energy efficiency summit in my District, and I have

done that every year since my wife and I built a new house, and I wanted to put solar panels on but the technology was not there, and they are terribly expensive, and my wife, who is the architect, said maybe we can just do this with off-the-shelf efficiency technologies: foam insulation, efficient attic systems so important in a Texas summer, the high-efficiency air conditioners.

So I guess my question is: You mentioned you can do the equivalent of 40,000 households, but we also have a lot of power out there in those households. And, while not everyone is going to build a new house, there are off-the-shelf retrofits that can be done on the existing housing stock. And every summer when we do this efficiency summit, I am impressed by the local builders who show up and talk about the things that can be done, the energy audit, finding the places in your home where the energy is not being utilized appropriately.

Presumably you have done that with your building in New York? Is that correct?

Mr. Malkin. I have done it with my building in New York, and I have done it with my home. And the interesting thing is that the paybacks in my home really to do the comparable work, because of the systems involved and the fact that it is an existing home and happens to be 100 years old, far, are far longer than with commercial.

My emphasis is: Go to where the money is. And the money right now, the low-hanging fruit is concentrated in buildings, big buildings: hospitals, office buildings, retail facilities.

I don't mean to say forget about homes altogether, but I do mean to say I think it is misdirected to focus on HomeStar when BuildStar or other things which address the commercial real estate industry could have a much more immediate, very near-term effect on our total energy demand, and can free up power and source of power for other uses.

I would emphasize, by the way, I would not want to bog this down with too much data, but the folks at Johnson Controls and Jones Lange LaSalle are readily available to testify at any time, and they have got all the data on this.

Representative Burgess. I hope we will call them.

You mentioned 67 things to do for energy efficiency. In the Empire State Building you concentrated on 8. Can you give us, in the interest of time, the top 2?

Mr. Malkin. I think the two most interesting things that we have done, one is we are taking 6,514 windows which are thermopane or duopane, installed 12 or 15 years ago, out of the building to a facility in the building with 5,000 square feet where we take them apart, clean them, put in a mylar sheet, reseal them with krypton argon gas. We take their energy efficiency from an R–2, energy resistance to transfer of energy, from an R–2 to an R–8.

We re-use 96 percent of the components: the frames, the glass. We reinstall them the next night in another floor. Through that process, we are greatly reducing the heat and cool transfer and reducing our load.

The second thing which I think is very interesting is we have a DDC system which is 100 percent, 24/7, 365 days a year operating

every variable air volume damper, every fan, every pump, every radiator. It's all linked. So we are not only curing the number one complaint in an office building, "too hot/too cold," but we are fine-tuning the building so that it runs at peak efficiency. And if it ever slips out of commissioning, you know it immediately, as opposed to every five years when you check.

Representative Burgess. I'm anxious to hear about the other six, but in the interest of time I do need to ask Dr. Greenstone, on the—of course we passed a cap-and—or they passed a cap-and-trade bill in the House, I guess I should say. It was an absolutely dreadful bill.

But when Al Gore came and talked to our Energy and Commerce Committee—and he did this twice—he talked about maybe it was time for a new paradigm and we get rid of the income tax, and the payroll tax, and just have a carbon tax, or an energy tax.

Have you looked into that at all? Replacing our existing tax codes with just purely an energy tax?

Dr. Greenstone. Congressman Burgess, I have not looked into replacing the income tax with a carbon tax. I think what is probably worth highlighting, though, is it is possible to design a carbon tax, or we can call it a cap-and-trade system, where the costs are minimized to American families.

Representative Burgess. It may be possible—I'm going to interrupt you—it may be possible, but we did not do it in that bill.

Let me just ask you this, because you mentioned about X prices, or national prizes. H.R. 5505 is an X Prize for dealing with nuclear waste. Now if we want Mr. Malkin to have his Tesla charged with noncarbon electricity generating, and it just seems like nuclear power would be the way to go. Any interest in us pursuing something like that?

Dr. Greenstone. I think it is important to pursue research and development into nuclear energy. It's got to be at the top of the list.

Representative Burgess. I would appreciate you looking at H.R. 5505 and giving me feedback on what you think.

Dr. Greenstone. I would be happy to.

[Document dated August 27, 2010 transmitting Dr. Michael Greenstone's answers to Representative Michael C. Burgess, M.D. appears in the Submissions for the Record on page 113.]

Chair Maloney. Mr. Snyder.

Representative Snyder. Thank you, Madam Chair.

I apologize for not being here earlier. I was at an Armed Services Committee hearing. I want to ask a two-part question, which all three of you may decide you do not want to respond to, and then my time will be done and your time will be done, but the first part of the question is:

We talk a lot about competing with the international community in terms of R&D and developing new technologies, and it's all about jobs, and who is going to sell what to whom. The first part of my question is: As part of that, though, should we not be encouraging Chinese investment in the United States? They are certainly willing to manufacture products that are part of new energy sources. Why are we not aggressively encouraging them to set up manufacturing plants here like we do with other countries and

other technologies? It seems like it would be a win/win thing for both the Chinese and the American people, the American workers.

And second, it seems like every few weeks there is some article about how aggressive the Chinese, the business community and government, are about buying up energy type resources and mineral resources around the world. And we read those, and we get alarmed. Is not the alarming part of it that American businesses are not investing in those areas? Are not the Chinese businesses doing what perhaps folks ought to be doing, which is, you're looking ahead and you think you need more energy. Should you not be making investments in countries that have the resources you need? Is there not a difference in risk tolerance?

Why are not U.S. businesses more aggressively going after investments overseas like Africa, recognizing that 50 years from now Africa is certainly going to be wanting to buy clean energy sources also? And if this is off the wall for all three of you, just defer to the next guy and we'll be done.

But Dr. Greenstone, any comment?

Dr. Greenstone. Thank you, Congressman Snyder. I think I will take on your first question.

We have too much labor that is not working right now, and too many American workers do not have jobs. And I think it would be a great idea to encourage investment from China, and all other countries, in the United States. And if we set up factories that are owned by others, those would still be jobs that American workers can have, and American workers can draw wages and support their families and I think that would be an important part of any economic policy.

Mr. Malkin. I would just like to say to your second question that, you know, where China is going, I was in Kenya visiting with my family and the roads are being made there, graded by Chinese engineers all up and down the country.

We have got the, what is it, the Corrupt Foreign Practices Act, or Foreign Corrupt Practices Act, I forget which it is. They don't have any such restrictions on where their capital goes.

But I also think that, you know, American capital is wonderful because it can be moved where it is best rewarded. And what I am trying to emphasize is, less reliance on overseas sources of energy, and to look at energy efficiency as a source of energy for our own country so we can really define what our requirements are and we can have less extension. That is a huge component of what has driven me to do what I have done, the work that we put together at the Empire State Building, really to make America stronger and less reliant on overseas. China is reliant on overseas because it has grown fast and does not have the resources to grow its economy.

Dr. Ward. I think that the oil industry is a great example of the research that has been plowed into it, and the jobs that have stuck in the United States. The U.S. is a world leader in technology, and seen as a leader in implementing that technology throughout the world.

In terms of competing internationally for jobs, I would imagine a lot of it gets down to labor costs when you go into the implementation and rolling out of the technology for a mass market. And that is a tough one to deal with.

I will pass on the second one because I think we are all about trying to create energy in the United States.

Representative Snyder. Except that if what we are saying is this is about jobs in which we sell products internationally, why would we not be saying there is a huge market in Nigeria 30 years from now, or 20 years from now, or 10 years from now for solar kinds of things? Or clean energy? And yet I think American business right now, when you combine European and American investment in Africa, it is much, much higher than Chinese, but the rate of investment today is much greater by the Chinese for reasons that seem to be one of risk tolerance more than anything else.

There is money to be made in Africa. There is money to be made making products there to sell to Africa. It is not just, Mr. Malkin, to sell, to bring energy back to the United States, that we are falling behind.

Thank you, Madam Chair.

Chair Maloney. Thank you very much. I would like to give Dr. Greenstone the opportunity to respond to your statement. You ran out of time. You were responding to Mr. Malkin's statement that we should be treating savings as energy, and if you would like to expand on that concept more, Mr. Malkin, or Dr. Ward, you are welcome to.

Dr. Greenstone. Thank you, Chair Maloney.

Yes, the point I was going to make is I think for too long our energy research has been focused actually on deployment, or subsidies for particular forms of energy. Sometimes it's oil. Sometimes it's coal. Sometimes it's solar. Sometimes it's wind. Sometimes it's for energy efficiency. However, deployment is really an activity that is best left to the private sector. Instead of favoring particular technologies, economic theory is clear, all technologies should be allowed to compete on a level playing field. The lone exception is in cases where there are what economists call externalities, like greenhouse gas emissions.

And what all those subsidies do is unlevel the playing field. And the thesis of my testimony was that if we take those subsidies and turn them into research and development, pure research and development that is focused on basic knowledge that no firm will undertake on their own because it will benefit all kinds of firms, not just their own firm, we can address these two challenges that have been bedeviling the country for several decades—which is U.S. competitiveness, and our increasing reliance on fossil fuels.

So switching from deployment to basic R&D I think will offer a lot of benefits.

Chair Maloney. Well, talking about research, in this weeks' *Newsweek*, the Ford CEO, Alan Mulally was talking about the challenges faced with coming up with a solution with the batteries, and he said what we need is a moon shot. We need a total commitment, as we had when we sent a man to the moon with government support, to come up with a solution for the batteries. And why is private sector, or government funding in this case, going to fill the gap? And why isn't the private sector investing in this? Once we do, I am confident that American businesses and researchers can come up with a solution. How does this compare to China, which is spending more money on battery research than we are?

And then to the point that Mr. Cummings made so eloquently—once we do come up with the new technologies, too often I hear from my colleagues the new technology, the new solar technology, has moved to another country to be developed and exported back to America.

Why can't we hold on to our innovations and our intellectual property and create the jobs and the products here in our own country? And I welcome Mr. Malkin and Dr. Ward for any comments on it, but do you think we need a moon shot, as the CEO of Ford says, for battery development? And once we do develop it, what then would keep that technology and jobs here in America?

Dr. Greenstone. I think we need a moon shot for research and development into energy, period. And batteries are obviously a key constraint. They constrain the electric vehicles. Storage also constrains the use of solar, due to solar's intermittency. And, you know, if I were in charge of research and development, I would certainly devote substantial resources to the basic understanding of how batteries work, and how to advance that.

As to your more difficult question of how do we ensure that the jobs stay here, I think there is no getting around that we have a global competition for jobs. We have a global competition for capital. And, as I mentioned earlier, what decades of economic research have shown is when ideas are generated in a particular place, they tend to stick in that place.

And so if we develop the ideas here in the United States, we can feel some confidence that the jobs will remain in the United States.

Chair Maloney. Mr. Malkin, in your—Dr. Ward?

Dr. Ward. One of the things I would like to bring up on the deployment of technology, though, I don't think the role of the government should be overlooked, because once a new technology is developed, if it is a very capital-intensive technology to roll out, then it takes a stable regulatory environment to ensure that the benefits can be realized.

There is a lot of risk on the private sector. And in addition to the stable regulatory environment, perhaps there ought to be some accommodation made by the government in terms of tax breaks for rolling out new technology. I have seen it be a breaking point on technologies that have been developed.

Everybody wants to be a fast follower, not a bleeding leader.

Chair Maloney. Again I have heard from my colleagues, where tax breaks and incentives have been given to develop technologies by businesses in their districts, then they have seen those businesses actually completely move to another country, after receiving quite a bit of government support to develop the technology and to develop the business.

So it is a challenge. And that is what I repeatedly hear from my colleagues as we discuss jobs.

I do want to go back to your rather major initiative, Mr. Malkin, of retrofitting the Empire State Building, which included private and nonprofit sectors. How could a government be most helpful in removing obstacles that you encountered in the process? What were the type of obstacles that you encountered? How could government be more helpful in helping other major buildings convert to save so much energy?

Mr. Malkin. I think there are a few things.

One, the common theme here is a stable regulatory environment and is very important. But I think also a regulatory environment, in and of itself, has some merit. What we did was we were able to convince the folks at Johnson Controls and Jones Lange LaSalle to, on speculation, commit millions of dollars of research, people power, men and women power, around a problem.

And they did it with the prospect of being able to go out and market this product. And I think they intelligently did it with the prospect of marketing a product which can be used domestically.

I think that it would be far better for the environment, it would be far better for the economic environment I mean, far better for businesses, if they knew what was coming at them from a regulatory perspective so that what they choose to do for their own profits' interest is not going to be countermanded or wasted based on future regulation.

I really do believe that what is happening is, particularly for large property owners, cities and states are coming up with their own regulations. Some of them are very enlightened, but many of them are conflicting. And if you are looking for the real estate industry, the commercial real estate industry, and large industries devoted around that, lending, construction and the like, the prospect of national codes, if it is going to be out there, it needs to come forward.

Otherwise, we are confronted with having to comply with numerous codes in numerous different jurisdictions, many of which—all of which we assume are well intentioned but could be conflicting and reduce efficiency in implementation.

Chair Maloney. Thank you. Dr. Ward? And my time is expired.

Dr. Ward. I couldn't agree with that more, in that as new technologies are developed and rolled out, the regulatory environment, the government, needs to be brought along with that technology so that they are familiar with it, so they know its strengths and weaknesses, and can come up with intelligent regulations for the application of it. You can't have one get ahead of the other. Thank you.

Chair Maloney. Thank you.

Mr. Brady.

Representative Brady. Thank you. I think whenever you lose a customer, especially a long-standing customer, you normally do not blame them. You take a hard look at yourself. I think one of the reasons companies are choosing to invest and innovate and create jobs overseas is that what used to be a very strong business climate in America has changed.

Other countries have taken a page from our playbook, lower taxes, less regulation, more innovation, better R&D tax credits, encourage innovation, and basically are beating us over the head with our own playbook. And until we re-create a strong business climate, and a job creation and innovation climate, we will not see those jobs return.

Dr. Ward, let me ask this from an academic standpoint. Dr. Greenstone, in responding to a question, made the assertion that fossil fuels contribute to higher infant mortality rates on hot days. In other words, oil and natural gas somehow contribute to more deaths of babies during hot days.

In all your scientific work dealing with offshore, onshore oil and gas production, is there any scientific basis for that assertion?

Dr. Ward. Not that I'm aware of.

Representative Brady. Aren't oil and natural gas, which we are trying to transition from our dependence on that to a more diversified portfolio both in our homes and in our cars and in our industry, which have traditionally been the most affordable, along with coal, the most affordable sources of energy, as opposed to wind, and solar, biomass, others. Has that changed?

And if you are looking at affordability, and that infant mortality rates are somehow tied to the ability to afford your energy, wouldn't that be more affordable for families than some of the alternative fuels that are being developed today?

Dr. Ward. Yes. Certainly oil and gas—fossil fuels in general are a more affordable means of providing energy in today's market. And if the idea is to provide better environmental systems for households and whatnot, that would certainly be the one that would be the most affordable until these alternative, cleaner sources become more available and affordable.

Representative Brady. Thank you. Dr. Greenstone also made the point that he could assure us there would be no price increases in oil here this fall, or apparently in the future. But when we have hurricanes coming to the Gulf, until there is assurance that there hasn't been a disruption, oil prices on a world basis tend to go up?

Dr. Ward. That's correct.

Representative Brady. If there's a hiccup in Nigeria's production, oil prices tend to go up. Can you, or anyone on this panel, assure us that energy prices will not go up as a result of this drilling moratorium?

Dr. Ward. I certainly can't. And I think that the price situation is so inelastic with oil and gas that any little hiccup, or big hiccup, certainly has immediate impact on prices.

Representative Brady. It is one of the reasons I think that we are hopeful there won't be an increase because demand is down. World demand is down right now. Will that demand ever increase? Will we move back to the point, as economies globally increase, where there won't be sort of like the credit card that's maxed out, you're out on the edge? That's been one of the drivers of energy prices, one of the reasons, Gulf production, which gives us that buffer against that, has been so helpful.

Dr. Ward. Right. Well I think the United States and every other country is very anxious for an economic recovery, and energy usage will certainly increase as the economies recover.

Representative Brady. One of the concerns that have been raised on the drilling moratorium is the loss of up to 300,000 jobs if we drive Independents from the Gulf. The rigs are already leaving. We have a global environment. Companies do not have to invest in the U.S., they choose to.

We are already hearing from companies that, as they plan their capital budgets, they are looking at investing capital, their precious capital, in other countries rather than doing it here in our backyard.

Does that mean, should we lose that investment, along with the rigs and the equipment and the jobs, does that also cause a problem for future production and future jobs in the United States?

Dr. Ward. Well I think that that is an opportunity that the majors have, but the smaller independents, which are an integral and important part of oil and gas production in the United States, do not have the luxury to go overseas as easily as a global company. We could lose those.

Representative Brady. Yes, we will lose them. What businesses can survive six months without their main source of revenue?

Dr. Ward. Not many. I know a number of people in the industry that have lost their jobs in the last three months.

Representative Brady. Thank you, Doctor.

Chair Maloney. Mr. Hinchey.

Representative Hinchey. Thank you very much, Madam Chairman.

And thank you, gentlemen. I think this has been a very interesting discussion, and I thank you very much for everything that you have been dealing with here.

I can't help but be deeply impressed about the energy use efficiency operation that you are engaged in in one of the most important buildings anywhere on this planet, the Empire State Building, and all of the things that are going to happen as a result of that.

I hope that is going to continue, that it is going to be more effective, and apparently the Mayor of the City of New York is closely involved in this, and he is working strongly to support it. All of that is very, very important.

I can't help but—in fact, I have been feeling this way for a long time, that solar energy is the most effective, most important, most useful way in which we can reduce our dependence upon fossil fuels and deal with the rising cost of energy, but also deal with this issue of global warming, which is becoming critically important.

As we know, 2005 was the warmest year that we have experienced on record. And it may be that 2008 or 2009 may be warmer than 2005. In any case, this is an important thing that we have to deal with.

In the District that I represent in Upstate New York, a couple of years ago we set up a not-for-profit corporation called The Solar Energy Consortia. As a result of that, we have generated a significant number of jobs, several hundred jobs, and we have got a number of companies that have come in that we are working with.

I will just mention two of them and the things that they are doing. One of them is developing a solar battery. And this battery is in the process of generating energy and being able to hold onto this energy for a long period of time. And the essential idea of that is to use it in automobiles for transportation. But of course that could be expanded very easily and used for a whole host of other things in addition to transportation.

Another company that we have has just set up the manufacturing of solar panels. And this company is the only company in eastern New York that is now manufacturing solar panels. And that operation is going to be expanding over the course of the next few weeks, and well into next year. The estimation is that in the

process of that one operation they will be hiring something in the neighborhood of 400 jobs over the course of the next several months, running into next year.

So I am wondering what you think about that operation. Shouldn't we be focusing our attention on solar energy? Isn't it the most effective and the most efficient? And Dr. Greenspan specifically, you mentioned that there are recommendations of U.S. energy research and development capacity that is going to be unveiled in 2011. And I wonder if you would give us some hints about what that unveilment is going to look like in 2011.

Dr. Greenstone. Thank you for your questions, Congressman.

I think there is no question that solar has got to be part of the suite of sources of energy, including energy efficiency, that should be researched carefully. Currently solar is not cost competitive in most settings. And I think further research and development could change that.

And as I said, we are going to be coming forward with some specific recommendations. I just tried to highlight five principles in my testimony, which they all boil down to increased funding, funding that is completely merit-based, funding that is focused on basic research rather than on deployment, or applied research, and attempts at using innovative funding techniques like prizes. And then also the support for demonstration of new technologies at commercial scale. Those are the broad principles I think that we are ready to talk about at this point.

Mr. Malkin. I think that the use of solar is important, again as part of a suite. We have had some very good investments in solar, both from production of solar as a utility with Sun Edison, which is a company which we recently sold, but also through companies which have made the conversion of sunlight to electricity more efficient. That is an investment we still have.

I think that it is very important with government policy to sponsor innovation. Only through repeated manufacturing will innovation come, breakthroughs come, both through research and the manufacturing process in determining where the bottlenecks exist, developing the supply chains.

So I think with wind and solar and geothermal—I don't want to miss the point—energy efficiency is five times less expensive now, but they will converge, because alternative energy sources will become less expensive, and the costs of achieving greater efficiency will become more expensive as we get rid of the low hanging fruit.

Representative Hinchey. Dr. Ward.

Chair Maloney. Yes.

Representative Hinchey. Dr. Ward.

Dr. Ward. No comment.

Representative Hinchey. No? Okay.

Chair Maloney. No comment. Dr. Greenstone has a comment.

Dr. Greenstone. Chair, thank you. I think my testimony or my comments might have sown a little confusion. I wondered if I could have just one minute to clarify them?

Chair Maloney. Sure.

Dr. Greenstone. I think I just wanted to respond to one of Congressman Brady's fine points. I think what Congressman Brady has really done is focus everyone's mind on the important point

that currently fossil fuels are the cheapest source of energy around. There's no getting around that.

And if we continue to use fossil fuels, that will save American families money, and that is something that everyone is obviously supportive of.

What I think my testimony was not perfectly clear about is: The continued reliance on fossil fuels also has a set of costs that are not quite visible, in the same way when you pay a utility bill every month. And those fossil fuels, what they do is, according to scientists, is they increase global temperature. And that increase in global temperature has a series of negative consequences—infant mortality being one of them, but there are a series of other ones. And I was only trying to highlight that we don't see those costs in quite the same way we do when we pay a utility bill every month, but those costs are real nonetheless.

And I think the second thing I want to clarify, which I feel my testimony might have sown a little confusion about, was that my statement was not about shutting down drilling in the Gulf forever more. My statement was that if we had a moratorium that lasted through September, it would not fundamentally alter total production of oil across the globe. And that the impact on prices through September, and potentially longer, would be difficult to discern.

I was not making a statement that if we stopped drilling in the Gulf forevermore there would be no impact on world prices.

Representative Brady. I appreciate that. Because as we know, the moratorium will go through November unless changed. But we actually—while I disagree with some of the climate change assertions—I think we actually—and, Madam Chairman, the reason I appreciate you calling this—I think almost all of us agree we need to get to a greener energy future.

How we make that transition is really sort of the debatable point right here, and how we do it in a way that benefits us all. This is not a zero sum game. We are going to need energy from all sources if we are going to be diversified, and affordable, and clean in the future. So we actually, while we may have some differences in how we get there, I think the point of your whole hearing is we need to get there.

Chair Maloney. Thank you. Mr. Campbell is recognized.

Representative Campbell. Thank you, Madam Chair.

And, Mr. Malkin, when I was doing my last questioning you made a comment that will cause me now to make a little bit of a view, give you a little bit of my perspective on things, of which all three of you are welcome to comment and say I am full of garbage, I am dead on right, or somewhere in between.

But I think there is a distinct difference between energy for mobile sources and energy for stationary sources. And the solutions for each are very different. The vast majority of energy for mobile sources in the United States today is petroleum based. It's cars, it's trucks, it's diesel, it's gasoline, et cetera.

The propulsion systems that are alternative to that, rather than internal combustion, are electric, which by the way, from the standpoint of the efficiency of the propulsion system, driveability of the propulsion system, is an excellent propulsion system. The problem is how you get the energy to it. And that is where batteries

become a barrier right now. And cost. And not just batteries, but their cost, their efficiency, and everything else.

Or in the case of like a fuel cell where you have a whole bunch of barriers—cost, and also what kind of fuel; actually the most efficient fuel because the infrastructure is already there to fuel a fuel cell today is still gasoline. So you still have that. So that is one set.

Then on the other set is stationary sources, which we're not talking about batteries but we're talking about producing it, and there most of the energy is either coal or natural gas based in the United States. There's obviously a lot of hydroelectric and some nuclear. But I see the barriers there as being substantially different.

Because people will say, well, we have to get off dependence on foreign oil, therefore we need solar. Well unless you can create a battery for a vehicle, solar does not help you with oil because there is very little oil that is used to create electricity in the United States.

So what you have got, if you want to displace natural gas or coal or both producing electricity, then there already is large hydroelectric, which produces zero emissions and is cheap, and there is already nuclear which produces zero emissions and is cheap, and those technologies exist, but there are a number of people who don't want to go down that path for one reason or another it seems. But the barriers over there seem to me to be considerably less than the ones in the mobile source, but that they are, no matter how you look at it, very different problems that have some overlap but not a significant amount of overlap.

And depending on what your objective is, whether it is a global warming objective, whether it is a dependence on foreign oil objective, whether it is a dependence on a national security objective, there are many different objectives people have for moving down this course. But as Mr. Brady says, I think we all understand that we want to move down this course. But I do think the two things have different solutions, and different challenges.

So with that, I will let you all comment on my little diatribe, if you desire.

Mr. Malkin. Yes. I totally understand from where you are coming, and I guess my comment would be, from what I am expert at, if I am expert at anything, is the energy efficiency piece.

We will free up that fixed base of energy generation. It will free up that fixed piece, and you can begin to look at reallocating the pool of things that are otherwise used for generating fixed. Get rid of some of the higher polluting sources. Start looking at different infrastructure for the transportation side.

And that is absolutely an issue, that we have an infrastructure for transportation to use fossil fuels. There are other alternatives, but they will require infrastructure, which, by the way, will require jobs and will require innovation.

Representative Campbell. Right. Okay, but I just—until you have a battery or something, you can't transfer that from fixed to mobile source until there's some technological breakthrough somewhere that doesn't exist right now.

Dr. Greenstone. Congressman, I think your categorization of the problem is spot on. And I think from sitting here, I am not a scientist, but it seems like we can see the way to get there on the

stationary sources. We are not there yet, but we can see the way to get there.

We are a long ways away in terms of dealing with mobile, or transportation. And I think that is where a lot of research and development spending should go. And I think Chair Maloney made that exact point when it comes to batteries, and I agree with that.

Representative Campbell. And there have been billions of dollars—and I am not saying it was sufficient—but both from the private sector and the public sector in the last 20 years on batteries, and we have not gotten there yet.

Now was it insufficient? Did we try the wrong way? Did we have it wrong—I don't know. But, you know, it is not because there hasn't been some effort. There has been a significant effort, and a significant reward to anybody who makes a breakthrough in the last 20 years. We just haven't gotten it yet.

Dr. Greenstone. I agree. And when I put together some of these statistics in my testimony, I was a little taken aback, frankly, that we have made serious investments in R&D, but from an international perspective we are falling way behind.

Chair Maloney. Thank you.

Mr. Malkin, you said in your testimony that policy should be informed by practice, and I couldn't agree more. We don't just need pools of money, we need to really have objective assessments.

Could you elaborate on how we would go forward with these objective assessments? How could we inform tenants about how much they pay per square foot? I know we have a LEED certification in New York. Is that working? And then you talked earlier about the need to change the EnergyStar assessments to a way that really looked at output in a more detailed way.

Would any of the panelists like to discuss that?

Mr. Malkin. I would just say that the number one issue for me is that we do have groundbreaking work that we are doing. We are only a little more than a year-and-a-half into its implementation. And we are now producing the data. And I think that that data and the fact that it works, and that the assumptions we had to make based on our research are actually now producing real, verifiable data. That's the practice which I think is helpful.

LEED is a qualitative destination. I agree with green practices. We recycle tenant waste. We recycle construction debris. We use recycled materials and low off-gassing materials in our buildings, but that does not really address the energy piece. And LEED is deficient in that.

EnergyStar is a terrific product put together by the U.S. Government. It should be upgraded to a new version which gets away from a relative measurement and gets into specific rating and disclosure of consumption.

You cannot get away from the fact that, if everyone consumed energy at an equal efficiency rate, everyone's EnergyStar rating would be 50, because it's a relative measurement. Therefore, it doesn't justify what the economic result will be, the savings you will get for the investment you get. And I think there is room for that. It is a good model which has done a lot of good but should be improved.

Chair Maloney. Any other statements? Yes, Dr. Greenstone.

Dr. Greenstone. Chair Maloney, I think I just want to amplify a point Mr. Malkin is making about EnergyStar, and actually something that relates to today's hearing more generally.

One problem in the energy market for consumers is it is not very transparent. So when you buy a computer, you know how much it costs today to pay to the Dell Corporation; you do not know how much it is going to cost to run it over time. I think different computers can have different rates of energy efficiency, just like different televisions do.

And currently the way that the government tries to provide information in that market is through these EnergyStar ratings. As Mr. Malkin has emphasized, those ratings are often qualitative, or give you a rank order, but they do not give you the fundamental information, which is: Well how much will it cost to run the thing?

And I think a reform of the EnergyStar program and more generally the provision of information that allows consumers to make more informed choices would be a tremendous reform.

Chair Maloney. Thank you so much. My time has expired. Mr. Brady, and it has to be our last round. We only have this room for a limited amount of time.

Representative Brady. No, Madam Chairman, thank you.

Chair Maloney. No questions? Well I want to thank all of our witnesses—Oh, Dr. Ward?

Dr. Ward. Could I make one more point——

Chair Maloney. Sure. Absolutely.

Dr. Ward [continuing]. In response to Dr. Greenstone's comment about the price of oil in the short term due to the moratorium. Probably by September or October not much would be noticeable. My concern is that, as rigs leave, and there is much less drilling in the Gulf of Mexico in the future years, that is where the real hurt will come. Thank you.

Chair Maloney. I want to thank all of our witnesses for their informative and enlightening testimony. We need to make smart decisions about how we invest in energy, and your testimony today underscores the need to add rigor to our assessment of proposals and the need to provide guidance on how these innovations can benefit energy consumption and consumers, and help preserve energy.

I would like to thank everybody for coming, and this meeting is adjourned.

[Whereupon, at 11:52 a.m., Tuesday, July 27, 2010, the hearing was adjourned.]

SUBMISSIONS FOR THE RECORD

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PREPARED STATEMENT OF CAROLYN MALONEY, CHAIR, JOINT ECONOMIC COMMITTEE

I am pleased to hold today's hearing on promoting innovation in the clean energy sector.

This is the second in a series of hearings held by the Joint Economic Committee on the role that innovation has on fueling employment and growth.

Innovation in the clean energy sector will improve productivity, enhance job creation, and improve the quality of life.

This hearing is timely for a number of reasons:

- The Senate plans on discussing energy legislation this week.
- The nightly news and the camera footage of the Gulf oil spill remind us of the human and environmental cost of this spill.
- While our economy is still raw from the devastating job losses experienced in the Great Recession, it is obvious that more robust growth is needed to reduce the unemployment rate. Innovation in the energy sector can help fuel growth in the future.

Innovation in the clean energy sector can also strengthen the economy by making it less vulnerable to economic downturns.

While the U.S. has weaned itself from dependence on oil in many sectors, progress to reduce our dependency on oil to meet transportation needs has been particularly slow.

At a hearing last May, Dr. James Hamilton testified that the oil price run-up in 2007–2008 was an important factor that contributed to the Great Recession.

He testified that the run-up in oil prices caused a plunge in auto sales, deterioration in consumer sentiment, a slowdown in consumer spending and problems in housing, especially in the ex-urbs, where commuting costs can rise significantly with gasoline price increases.

Continued reliance on oil leaves the economy vulnerable to sharp increases in oil and gasoline prices and could potentially derail the economic recovery now underway.

It appears that when oil expenditures reach 4 percent of GDP, the US is at risk of falling into a recession. (See Chart)

Currently, the share of GDP spent on oil is 3.5 percent, much higher than in 1993, when the share of oil GDP spent on oil was 1.8 percent, but better than the 6.8 percent in mid-2008.

Innovations in the clean energy sector can reduce our vulnerability to oil price rises.

These innovations may arise from a variety of different sources:

- New technologies to produce energy,
- New forms of energy, production of existing fuels or energy in a cleaner or more efficient manner, or
- New ways of reducing our consumption of energy.

In our hearing last month on innovation, witnesses testified that federal spending on basic research in universities can provide the spark that ignites regional economic growth and job creation.

Universities, with help from venture capitalists, have emerged as both producers of ideas and active players in the innovation chain, creating startups that are among the most successful small businesses.

But witnesses at our last hearing also testified that there is not enough funding or research in the energy sector.

However, Congress and the Administration have recently increased our country's commitment to clean energy.

The Recovery Act invested more than $90 billion in clean energy, including:

- Investments in energy efficiency,
- Advanced vehicles,
- Clean energy equipment manufacturing, and
- Mass transit and high-speed rail.

Additionally, the America Competes Act, passed by the House on May 28th, supports innovation and basic research by creating new Clean Energy Consortiums in a public-private partnership.

America Competes also seeds game-changing innovation through the reauthorization of Advanced Research Projects Agency for Energy (ARPE-E), and directs ARPA-

E to help ensure that these promising technologies are shared with the private sector.

Federal investments can be especially effective when the funds are combined with private sector investments.

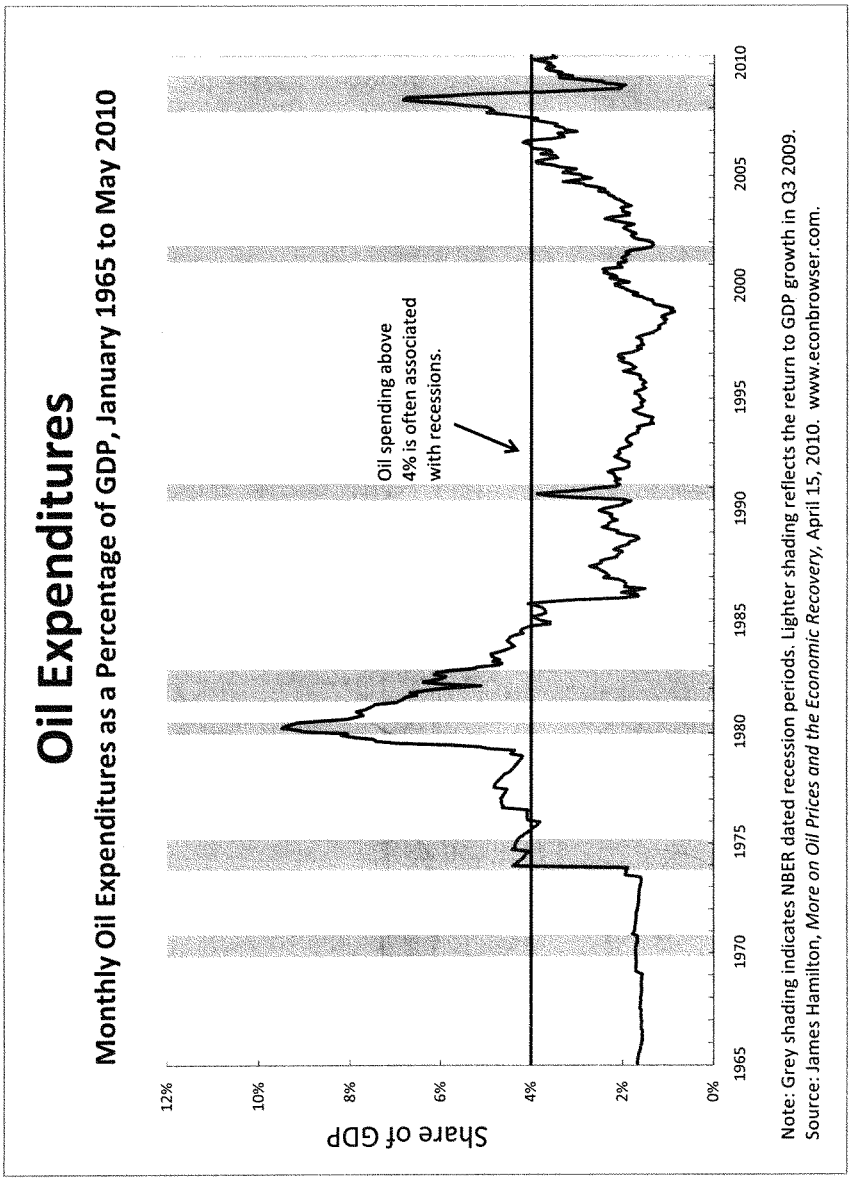
Just two weeks ago, CEA Chair Christina Romer testified before this committee that $46 billion in public funding in the Recovery Act encouraged an additional $100 billion in investment by the private sector in projects related to clean energy.

I am especially pleased that my fellow New Yorker, Mr. Anthony Malkin, is here to testify about the energy efficiency retrofits he is undertaking to one of our greatest cultural icons, the Empire State Building.

New lighting, windows, and heating and cooling systems reduce the amount of energy tenants use while improving the quality of their space.

I am eager to discuss with our panel how Congress can ensure that these needed investments in a clean energy economy will occur, leading us to a stronger economy with good jobs and a cleaner planet.

I welcome each of you this morning and look forward to your testimony.



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PREPARED STATEMENT OF REPRESENTATIVE KEVIN BRADY

I welcome the chair's decision to hold a hearing on energy matters at this time, and I welcome the panelists to what I hope will be a substantive discussion of energy supply and environmental issues. I find your submitted testimony very encouraging in this regard.

To observe our Administration's energy decisions is to wonder whether it has any comprehension of the future energy supply challenges our nation faces.

The ill-conceived Gulf drilling moratorium flies in the face of everything common sense tells us about our precarious energy future and what we should be doing about it now.

The drilling moratorium is already killing well-paying American energy jobs, sending rigs overseas and with them our workers, equipment, capital and eventually America's traditional energy infrastructure. Given the global nature of energy production, these rigs won't be returning anytime soon.

What's more, President Obama has not even responded to our invitation to travel to Houston, Texas, to meet face to face with the energy workers and small businesses whose livelihoods are at risk due to the moratorium.

Yet the President will be traveling to Houston on August 9th to raise campaign cash for the Democratic Party. We've asked him for just an hour of his time, or even just 15 minutes of his time, to meet with our workers and businesses. But as of today, just silence from the White House.

Mr. President, can you spare any time at all for these Americans whose jobs you are killing and sending overseas? Where are your priorities?

Neither the White House nor Congress seem to understand that the current relative lull in energy demand results from a weak economy. It doesn't mean that we have the luxury of halting large-scale energy projects and betting our future on small-scale alternatives that we all support but are not yet ready to affordably meet America's energy needs.

The Gulf of Mexico accounts for 19% of the nation's total proven oil reserves and 30% of total U.S. production. Solar and wind technologies together account for less than 1% of the nation's energy supply. In 2008, the Gulf of Mexico's outer continental shelf had the largest amount of new oil field discoveries in the U.S., which increased its proven reserves while oil reserves fell for the nation as a whole.

By all means, let's help renewable energy develop its potential, but let's not foolishly thwart the growth potential of our established energy industry which provides the affordable bridge to America's green future.

After 50,000 wells have been drilled in the Gulf's federal outer continental shelf and nearly 4,000 in deep water without a substantial spill, how could anyone jump to the conclusion that the BP accident points to an imminent systemic threat and shut off all deepwater drilling? And who would bet America's economy on subsidized wind and sun energy when there are private companies investing billions of dollars to develop deepwater oil and gas reserves off our shores? Does this make any sense? Where is the cost-benefit analysis?

A recent study by IHS Global Insight found that if policies were adopted by Congress or the White House that effectively prevent independent oil companies from participating in future Gulf offshore development the employment loss would reach 300,000 jobs—and the loss of local, state and federal revenues would total $147 billion over the next decade.

That's because independent energy producers hold the majority interest in 81% of all producing leases in the Gulf of Mexico and nearly half of those in the deepwater.

This week, rather than the House of Representatives hastily rushing through legislation with far-reaching impacts on jobs, energy prices and energy security, it would be much wiser to bring together science, industry and government in partnership to develop a thoughtful, safe and prosperous path forward to Gulf exploration and development.

Our national economy, already suffering with 9.5% unemployment and a subpar recovery, cannot be harmed further with a devastating drilling moratorium and hasty legislation that kills jobs and makes us more dependent on foreign oil.

Natural gas is a cleaner fuel than oil or coal and can be a suitable substitute for both in many applications. As of 2008, the U.S. had experienced the sixth consecutive yearly increase in natural gas discoveries.

In October of last year, the Energy Information Administration said "Today, increases in shale gas proved reserves reflect the industry's rapidly maturing ability to apply two technologies to shale formations: horizontal drilling and hydraulic fracturing."

Why is this important? Not because U.S. oil consumption is rising—it has been declining for several years—but because industrialization the world over will continue to increase oil demand. China now is the world's largest energy consumer. Our mindset should be how government can work with industry to develop safe operating standards for an energy source such as unconventional natural gas. It already has attained a commercial scale, moved the needle in the right direction on our energy reserves, and is relatively benign environmentally.

The Administration and Congressional Democrats operate by assertion, not by performance metrics, be that with jobs, energy supply, or the environment. The work of our witnesses today shows how important it is to apply the proper metrics to federal policy and quantify the effects of regulation, good and bad. Dr. Ward's work shows a potential 29% reduction in the cumulative Gulf oil production through 2016 from an extended drilling moratorium. Dr. Greenstone has shown how environmental regulations can retard industrial growth. He also has found that there is, in fact, no consensus on whether the Clean Air Act is responsible for the dramatic improvements in air quality that have occurred in the last 30 years. Mr. Malkin demonstrates the importance of designing government policy with an understanding of how businesses do their financial analysis.

Gentlemen, our approach to regulating the economy in this country must change. I look forward to your advice.

Remarks
Joint Economic Committee
27 July 2010

My name is Anthony E. Malkin, I am president of Malkin Holdings, and I run the Empire State Building. Seated behind me are Empire State Building Team leaders Paul Rode of Johnson Controls and Dana Schneider of Jones Lang LaSalle. Other team members in our work are the Clinton Climate Initiative and the Rocky Mountain Institute. I am a member of the Real Estate Roundtable and Duane Desiderio of RER is also present.

At ESB we created the first replicable, nonproprietary, open source, quantitative process to give transparent economic justification to energy efficiency retrofits in the existing built environment. Our work is guaranteed by the balance sheet of Johnson Controls to reduce our watt and BTU consumption by 38.4%. Our contract only guarantees 90% of our projected savings, so our actual savings will be in excess of 40%. Our payback period is three years.

It is estimated that in major American cities, 85-95% of all buildings which will be here in 2035 are here today. Building new and efficiently will not move the needle on energy consumption. Only addressing the existing built environment will make a difference.

Let's use New York City as an example. 80% of the energy consumed is consumed by buildings. 20% of the buildings consume 80% of that energy. Therefore 64% of all energy consumed in New York City is consumed by 20% of the buildings.

If the 20% of buildings in New York City which consume 64% of all energy deployed our program to the same effect, total energy consumption in New York City will be reduced by 25%. In the process, inner city jobs are created, skills are taught, and local economies are stimulated.

That is the equivalent of creating surplus power through alternative generation right in the middle of New York City, carbon free. But generating our savings is 3-5x/watt less expensive than alternative energy generation by wind, solar, or geothermal. Until the cost of a watt of alternative energy generation equals the cost of a watt of savings, we must focus on savings. You get the same carbon reduction with better economics and no infrastructure cost.

Creating this excess power allows for a number of options:

- shut down the sources of power;
- create carbon credits for trading; and/or
- reduce the size of investment in the smart grid for distribution of new sources of power

What can government do?

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- Treat the reduction of the consumption of energy as the production of energy through alternative, low carbon output sources.
    - Allow for the sale of tax credits, accelerated depreciation, and expensing of capital expenditures to help fund and reduce the net cost of such work.
    - These financial incentives will encourage building owners to make investments which address broad, intelligent policy objectives.
- Focus on the big energy consumers first.
    - As an example, Empire State Bldg consumes the equivalent in one day of 40,000 single family homes.
    - The focus on the community model for creating residential energy saving has been misplaced.
    - Focus on big energy consumers with big systems to effect fast and rewarding change.
- Develop national standards for energy consumption reporting.
    - To understand energy consumption we must share consumption data.
    - Individual cities and states are approaching this issue independently.
    - We need one set of standards rather not conflicting standards.
- Change EnergyStar from a database of relative measurement to a reporting and rating program based on actual consumption data.
    - ESB has earned an EnergyStar rating of 90, with only half our work completed; that means we are more energy efficient than 90% of comparable buildings of any age.
    - But EnergyStar is only a relative rating system which does not provide a return on investment measurement or argument.
- Understand limitations.
    - We need a framework which recognizes realities and differences by building types, systems types, uses, and geographical locations.
    - Allow for life cycle analysis instead of wasteful edicts.
    - Significant savings are within tenant controlled spaces, and legislation can not merely impose on landlords, but must address users as well.
- Reward successes and encourage first movers.
    - The real estate industry is inherently competitive.
    - Owners and lenders who are early movers should be rewarded.
    - This will differentiate them and encourage others to catch-up.

We are the future; we are not motivated by "doing the right thing", but by making money. I look forward to answering your questions and finding ways in which the Empire State Building can inform government policy with the practices we have developed. I encourage you to visit our website www.esbsustainability.com and our building to learn more.

Thank you very much.

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JONES LANG LASALLE

Real value in a changing world

CLINTON FOUNDATION

CLINTON CLIMATE INITIATIVE

ROCKY MOUNTAIN INSTITUTE

Johnson Controls

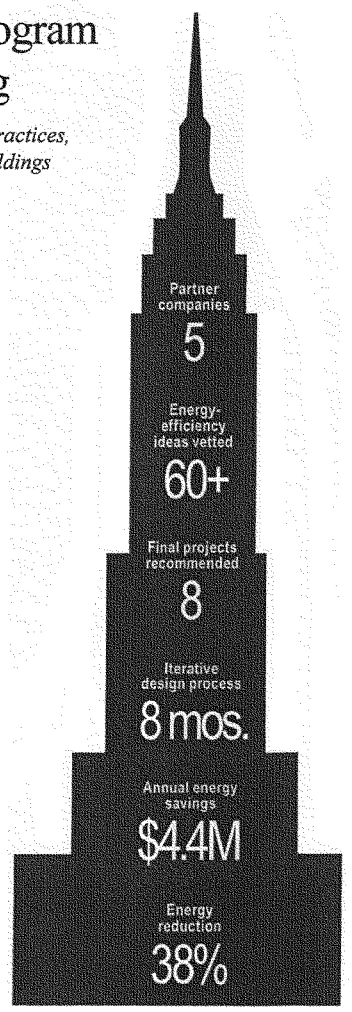
A landmark sustainability program for the Empire State Building

A model for optimizing energy efficiency, sustainable practices, operating expenses and long-term value in existing buildings

Efforts to make buildings more environmentally sustainable have produced hundreds of millions of square feet of greener office space. But tens of billions of square feet remain in office buildings worldwide for which owners have made little or no progress in the areas of energy efficiency and sustainability.

Owners of multi-tenant buildings, which comprise the bulk of office space, are primarily motivated by return on investment. To justify the costs associated with energy efficiency retrofits, owners must be convinced that the investment will be repaid by some combination of reduced operating expenses, higher rental rates and greater occupancy levels. The percentage of tenants willing to pay higher overall occupancy costs for green space is not large, and tenants that greatly value sustainability gravitate towards newer buildings that have been designed and built to higher energy and environmental standards. In general, the incremental cost of retrofitting older buildings to achieve improved energy perfromance is more expensive than the incremental cost of achieving the same performance in a new building.

This context underscores the extraordinary nature of the commitment that Anthony E. Malkin of Empire State Building Company has made to establish the Empire State Building as one of the most energy efficient buildings in New York City, and arguably the world's most environmentally conscious office tower built before World War II. Just as extraordinary as Malkin's commitment to retrofitting the Empire State Building was his decision to make the process transparent so that other building owners–particularly those with pre-WWII or landmark properties–would have an example to follow in pursuing their own green projects.



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Empire State Building Energy and Sustainability Team

- *The Clinton Climate Initiative*, a project of the William J. Clinton Foundation, was founded in August 2006, to create and advance solutions to the core issues driving climate change. As a part of its work in cities, CCI works with building owners to reduce greenhouse gas emissions from existing buildings. Acting as facilitator and convener, CCI helps further develop & validate the owner's vision, and introduce potential implementation mechanisms for the team.
- *Jones Lang LaSalle*, a global real estate services firm with the industry's leading sustainability services program, serves as the program manager and owner's representative, guiding the team through the highly collaborative process and taking the lead on areas of integrated sustainability beyond energy efficiency and the attendant reduction in greenhouse gas emissions.
- *Rocky Mountain Institute*, a nonprofit organization recognized as a leader in energy-efficient solutions, provides vital expertise and conducts peer reviews on technical and design elements of the energy work in the building.
- *Johnson Controls Inc.*, a global Fortune 100 company focused on creating effective interior environments, performs the engineering, procurement, and construction work under a performance contracting framework that guarantees savings and provides long term energy management.
- *Empire State Building Operations* acts as the site champion, to ensure that operations are not disrupted by the retrofit.

To ensure that this commitment was achievable, Malkin worked with the Clinton Climate Initiative to assemble a team of best-in-class consultants in the fields of climate change, real estate sustainability, environmental design and energy services.

This brief paper details the process for assessing, quantifying and documenting the costs and benefits of potential strategies for enhancing energy and sustainability at the Empire State Building. This process led to the adoption of a set of final strategies that, upon implementation, will reduce the Empire State Building's energy use and carbon footprint by up to 38 percent.

Empire State Building—one of a kind

As the Empire State Building is no ordinary office tower. The world's most famous office building, it draws between 3.5 million and 4 million visitors each year to the Observatory on the 86th floor. At a height of 1472 feet (449 meters), the spire is used for broadcasting by most of the region's major television and radio stations. Its 2.8 million square feet of leasable office space hold a range of large and small tenants, drawn by the building's prestige, its unmatched skyline views and its convenient location at the center of Manhattan's mass-transit system. Opened in 1931, the building has undergone recent upgrades of lobbies, hallways and other common areas including the just-completed renovation of the observation deck--restoring the building to its original grandeur.

Vision beyond the Empire State Building

"Buildings in New York City create 65 to 70 percent of the city's entire carbon footprint," Malkin told Metro Green + Business in June 2008. "Constructing new green buildings won't move the needle in mitigating this problem. It is far more important to address the existing building stock."

About 43 percent of all the office space in New York City was built before 1945, including a majority of the 10 million-square-foot portfolio owned by partnerships affiliated with Malkin and other principals in Wien & Malkin. W&M has instituted green practices across its New York portfolio, such as using integrated pest management and green cleaning products, and using energy-efficient maintenance vehicles. The

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Empire State Building signed onto the Energy Star program for buildings to measure and report its energy efficiency as soon as the U.S. Environmental Protection Agency and Department of Energy expanded the program to include buildings.

Motivation

The main motivation for the project was ownerships desire to prove or disprove the cost-effectiveness of energy efficiency retrofits. Secondary motivation included a desire to reduce greenhouse gas emissions and operating costs. Lastly, ownership wanted to address other aspects of sustainable operations including issues such as water conservation, recycling, reuse of building materials, reduction of chemicals and pollutants, and indoor air quality.

These changes are anticipated to enhance the Empire State Building's long-term value based on the opportunity for higher occupancy and rents over time. Green buildings have a competitive edge in attracting companies interested in reducing their own carbon footprints as well as providing work environments that promote the health and well-being of employees. Furthermore, eventually buildings could be affected directly or indirectly by sustainability-inspired regulatory changes at various levels of government.

Malkin and his team also knew what many do not: A market is emerging for financing capital improvements based on the cash flow from reduced energy costs. Developing a solid business case for these financing avenues requires a robust analytical process that produces valid data on retrofit costs and energy cost reductions. "We will be working to establish a financing format to provide the ability to otherwise indebted properties to participate in this sort of project, though the work on this project is not financing contingent and is going forward out of already available cash," Malkin said.

A multi-phase analytical process to establish a replicable model

Between April and November 2008, the collaborative team followed a comprehensive process to determine which energy and sustainability strategies could be implemented at the building, and what costs and obstacles might arise for each strategy. The purpose was to determine where cost and benefit intersected to result in the most sustainable building possible within reasonable cost parameters.

Expected income stream enhancements:

- Reductions in existing capital improvement program costs
- Reduced utilities budget due to greater efficiencies in energy and water usage
- Reduced building operations budget due to lower maintenance and repair costs
- Increased rent and occupancy due to enhanced value placed on updated services
- Additional income from new tenant service offerings, such as chilled water and emergency power

Initially, the team decided to consider criteria established by Leadership in Energy and Environmental Design (LEED®), established by the U.S. green Building Council, as well as Green Globes, a system administered in the U.S. by the Green Building Initiative and in Canada (under the more widely recognized name Go Green) by BOMA Canada, as points of reference rather than goals to be achieved. The comparative process of determining the building's current status along with the development of strategies that could feasibly be implemented in order to achieve increasing levels of LEED® for Existing Buildings: Operations & Maintenance (EBOM) certification was called a LEED® Gap Analysis. Incorporating comprehensive sustainability initiatives with the aggressive energ reduction projects, we developed a plan for the Empire State Building to achieve LEED® EBOM Gold certification.

Before the multi-phase program got under way, an initial presentation laid out program goals, the anticipated roles of each team participant and the framework for ensuring an organized, thorough process. Goals included:

- Develop a replicable model for retrofitting pre-war buildings in a cost-effective way

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- Develop practices to lower energy consumption costs by as much as 20 percent
- Increase overall environmental benefits of building retrofit through an integrated sustainability approach to maximize opportunities and market advantage
- Encourage the team to be objective, creative and provocative in its approach
- Develop a model that is marketable to existing and prospective tenants
- Coordinate with the ongoing capital projects within the building
- Develop a financial structure that is efficient and achievable

As Program Manager, Jones Lang LaSalle's role was to ensure team collaboration, stakeholder communication and timely execution, as well as to drive performance measurement and documentation of the repeatable model for industry-wide use. Jones Lang LaSalle and Johnson Controls developed a Sustainability Metrics Model for Greenhouse Gas Emissions, using internationally-accepted, scientifically-based data and calculations to evaluate the reduced impact on global warming and local environment resulting from the implementation of sustainability measures.

Under the initial proposal delivered in April 2008, the four-phase analysis would include:

Phase I: Inventory and Programming
Phase II: Design Development
Phase III: Design Documentation
Phase IV: Final Documentation

The four phases were completed in seven months.

Phase I: Inventory and programming

Team members conducted reviews of the building's mechanical systems and equipment, calculated tenant energy usage, and developed a baseline energy benchmark report and a preliminary system for measuring energy efficiency. A gap analysis was conducted to determine which LEED® and Green Globes criteria the building was already meeting, and which could be achieved feasibly. A plan was developed for the creation of pre-built green offices to serve tenants with an immediate need for finished space. The team steering committee met twice to discuss progress and refinements to the program, and Johnson Controls and Rocky Mountain Institute conducted a separate cross-functional workshop to look specifically at lighting strategies.

The central initiative involved in the inventory and programming phase, however, was the integration of the team's goals with goals of a separate capital projects team already in place. When the energy savings program got under way, the Empire State Building had already embarked on a major capital program that included a combination of restoration and upgrades to lobbies, hallways, restrooms and other common areas. A key element of the capital program was to enhance the experience of the building's primary attraction, the observation decks on the 86th and 102nd floors.

Process of elimination

1 Identify opportunities

- 60+ energy efficiency ideas were narrowed to 17 implementable projects
- Team estimated theoretical minimum energy use
- Developed eQUEST energy model

2 Evaluate measures

- Net present value
- Greenhouse gas savings
- Dollar to metric ton of carbon reduced
- Calculated for each measure

3 Create packages

- Maximize net present value
- Balance net present value and CO_2 savings
- Maximize CO_2 savings for a zero net present value
- Maximize CO_2 savings

4 Model iteratively

- Iterative energy and financial modeling process to identify final eight recommendations

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The process of value-engineering existing capital projects was a high priority for the newly assembled sustainability team as a way to avoid having to make changes later.

To accomplish the process effectively, an integrated team approach was adopted to deliver building services with minimal disruption to tenants and visitors. The Empire State Building Company capital program team, led by Jones Lang LaSalle and building ownership as project manager, guided work performed by TPG Architects, mechanical-electrical-plumbing (MEP) consultant Lakhani & Jordan Engineers and others. For the sustainability program, a separate project management team of Empire State Building Company and Jones Lang LaSalle interfaced with the capital program team and worked with Johnson Controls and the Rocky Mountain Institute who identified opportunities for energy savings.

The integration of the capital team and the energy savings team allowed the latter to pursue a "whole-building" approach, modifying existing capital project strategies so that they conformed to higher standards. In so doing, the team could make the building more green while staying within budgetary parameters. Expertise from members of the energy savings team suggested ways to lower the cost of several capital projects while enhancing environmental factors such as energy, water and ventilation.

The integrated team started by identifying baseline budgets for 23 existing capital projects and then examined how sustainable alternatives could affect costs. In its Inventory and Programming report, the team reported that energy savings options would result in a high level of savings on six projects. The team recommended putting four of those projects on hold while they examined alternatives thoroughly, including a multi-year cooling and air handling replacement program, central cooling plant replacement, exterior tower lighting and mid-pressure steam riser replacement. In addition, the corridor renovation project—the largest single budget item in the capital program—was viewed as a potential opportunity for greatly reduced costs by reviewing lighting and providing an optional air handling design.

Another six projects were seen as candidates for moderate cost reductions by following sustainable strategies. Among other things, the project team recommended exploring gray water sources in restroom renovations and looking at modular green roof alternatives on selected setbacks. As the capital projects team worked toward the resolution of these items, the team pursued a parallel track to identify additional opportunities not contained within the scope of the original projects.

In the final Phase I report delivered to ownership on June 2, 2008, the team listed the following accomplishments:

- Development of a Project Charter
- Knowledge sharing within the team via: weekly team reports, bi-weekly team calls, two full-team workshops and a third workshop for lighting, and establishment of a Sharepoint site for all team members
- Feedback gained from building stakeholders, including a tenant sustainability charrette to discover green tenant needs
- Collaboration with building operations to implement immediate systems improvement measures
- Review of existing capital projects and implementation of a lobby lighting test case for energy improvement
- Measurement and verification of building equipment and conditions to establish a baseline for energy and sustainability performance
- Strategy session engaging advisory expertise, ownership and teams
- Development of a Sustainability Scorecard, LEED® EBOM Checklist and Green Globes Report

The Project Charter stated the team's mission succinctly:

The retrofit of the Empire State Building into a Class A pre-war trophy building will transform the global real estate industry by transparently demonstrating how to create a competitive advantage for building owners and tenants through profitably greening existing buildings.

Outcomes of the first phase included a cost reduction of the baseline capital project of between three and four percent based on the review and suggestions of the team and a preliminary budget for energy projects compared to

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projected annual energy savings. This budget indicated a payback period of 15 years for energy-related work based on current energy costs; however, when the savings from the capital projects budget was considered, the payback period eventually was reduced to about five years.

Phase II: Design and development

By the time the Phase II kickoff meeting took place in early July, the team had already made substantial progress on several fronts: documenting tenant energy use, conducting preliminary mechanical tests, and refining criteria for measuring and benchmarking efficiency. The team was nearing completion of the LEED® gap analysis checklist for the base building, and a similar checklist for tenant spaces also was under way.

Goals of the Design and Development phase as reported to ownership on July 15 included:

- Create "360-degree" understanding of resource use at ESB (summarize in Baseline Energy Benchmark Report)
- Develop theoretical minimum energy use at ESB (identify key levers of energy reduction potential)
- Outline sustainability recommendations for pre-built spaces
- Initiate tenant engagement and design partnerships
- Begin development of energy-efficiency measures
- Continue development of project tools (Sustainability Scorecard, LEED®, Green Globes, GHG Protocol)
- Complete Phase II Deliverable Report

An important element of the design and development phase was to narrow the myriad of issues down to a manageable number of potential solutions, essentially creating order out of complexity. This winnowing process occurred throughout all four phases of the program, but it was in the second phase that consolidation of issue resolutions into a relatively small number of likely scenarios would become most prevalent.

In the Design and Development phase, Johnson Controls presented the Baseline Energy Benchmark Report in mid-July. The report examined energy usage between April 2007 and May 2008 from several perspectives:

- A month-by-month breakdown of electricity usage by kilowatt-hour, of steam usage by Mlbs, and the cost associated with each, along with a total energy cost, both with and without the broadcast towers
- Month-by-month breakdowns of electrical and steam usage showing the amount of energy expended toward lighting, ventilation, broadcast towers, main plant cooling, tenant sub-metering and other uses
- An annual breakdown showing the share of total energy expended that went to different tasks, including broadcast (23 percent), radiator heating (17 percent), lighting (16 percent), main plant cooling (15 percent), tenant sub-metering (7 percent), steam cooling (4 percent), and ventilation (5 percent), as well as the same data without including broadcast uses
- Areas of opportunity for using steam power more effectively, in particular radiator steam load (60 percent of total achievable gain), base load steam (19 percent), steam chiller (15 percent) and AHU HW HX (6 percent)

Rocky Mountain Institute also discussed its findings in examining theoretical minimum energy usage to address occupant comfort requirements, passive measures and other systems impacts, system design characteristics, technology, controls and changed operating schedules.

By raising the cooling set-point, enhancing the envelope and ventilation, reducing internal gains and improving cooling efficiency, Rocky Mountain Institute estimated that the building could reduce non-broadcast energy usage by up to 65 percent; however, the implementable minimum reduction under the existing charter was between 15 and 25 percent. Rocky Mountain Institute's analysis suggested that a reduction of 40 to 50 percent was not merely theoretical but achievable—if the cost-benefit equation did not devolve into a cost-avoidance strategy in the latter stages of the process.

Rocky Mountain Institute also discussed several issues that needed to be addressed. These included the challenge of incorporating bold concepts within conventional budget limitations, providing incentives for tenants to follow the team's guidelines, designing more efficient HVAC systems

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while recognizing that loads are likely to increase over time and the challenge of achieving maximum efficiency gains by getting all parties to commit to average load reduction and life-cycle costing rather than merely efficient system design.

The July presentation also provided Johnson Controls and Jones Lang LaSalle the opportunity to make recommendations on sustainable tenant pre-built spaces, comparing two potential options to standard pre-built spaces from an architectural, mechanical and lighting standpoint. Recommendations included reducing the number of interior wall enclosures to enhance natural light and views, selecting interior finishes to support sustainable goals and using task lighting to complement higher efficiency overhead lighting.

At the closing of Phase II, the team also set forth the goals for Design Documentation in Phase III:

- Complete Tenant Energy Management Report (guidelines for existing tenants)
- Complete Pre-Built Space Design Report (design for new pre-built spaces)
- Complete 90 percent of eQUEST model (test and understand key hypotheses)
- Begin financial modeling of synergistic combinations of measures, not isolated measures
- Begin in-depth lease review and tenant surveys
- Develop LEED® EB and CI Feasibility Report
- Complete Phase III Deliverable Report

Phase III: Design documentation

Phase III of the analytical process centered on two major deliverables: a final report assessing the tenant energy usage and the impact of pre-built spaces; and the development and refinement of the eQuest Energy Model.

The tenant energy program had four basic components:

1. Establish electric sub-metering for each tenant so that energy used by the tenant can be displayed and compared to industry norms via a dashboard linked to the building web page.
2. Identify key building personnel to be the face of the program, suggest each tenant designate a point of contact. Provide training to the contact so they understand the basics.
3. Provide education through online training, and seasonally-specific recommendations and best practices for tenants to reduce their carbon footprint.
4. Report on progress.

Tenant energy usage had been documented over a period of months ending in mid-August. The team had discussed ways for the building's facility management staff to easily monitor energy usage of each floor and each tenant on that floor. The proposed plan was to create a computer "dashboard" that would automatically translate numeric data into visual data such as charts and graphs so that managers could more easily spot trends and act on them. A typical tenant's data might show month-to-date and year-to-date energy usage in terms of kWh and cost, as well as high, low and average usage per square foot and a month-by-month breakdown of actual and ideal usage.

The plan as proposed to ownership on August 27 was to optimize energy systems floor by floor as spaces became available through vacancy or restacking tenants within the building. Following the building's existing restacking plan, 14 floors could immediately be made available for optimization, with up to 33 floors available for optimization by the end of 2011.

At this phase of the analysis, the team also had final plans in place for pre-built tenant spaces and had started the vendor bid process. Different pre-built layouts had different energy savings impacts, and the team developed multiple scenarios to achieve different levels of energy efficiency within these spaces. The cost of the different scenarios exceeded the cost of non-sustainable pre-built spaces by 6.5 percent to 12 percent.

The most sophisticated element of the Design Documentation phase was the development of the eQuest Energy Model. Drawing on a program developed by the U.S. Department of Energy, the model was designed to be used for cost / benefit analysis for future improvements, modifications and operational changes. The purpose of the eQuest Energy

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Model was to compare the energy consumption baseline to various facility improvement measures in order to calculate energy savings of these measures on a stand-alone basis and in combinations with other measures. The team created a matrix that analyzed the costs and financial benefits of facility improvements and other potential green strategies, and integrated the data with sustainability ratings, architectural programming and operational best practices, creating a comprehensive sustainability scorecard. The result was a sophisticated understanding of how different strategies, implemented individually or in various combinations, would affect project cost and building performance.

Johnson Controls and Rocky Mountain Institute conducted parametric runs on strategies relating to chillers, heating units, water pumping equipment, air handling units, controls, co-generators, lighting, plug loads and the building envelope. These exercises helped identify scenarios that would provide the most value, taking into account life-cycle costs and benefits, economics and logistics of implementation. For each scenario, the team needed to document variables that could affect the results. For example, if tenant engagement and adoption rates were higher or lower than anticipated, or if more of the building was used for broadcast than anticipated, there could be an impact on the estimated results. Recognizing these variables and attempting to quantify their impact was a significant element of the analysis.

Phase IV: Final documentation

The final phase of the analytical process was to create an Integrated Sustainability Master Plan Report, synthesizing data from all available standards and measurement tools, including ENERGY STAR, LEED®, Green Globes, eQUEST Energy Modeling Tool, the Sustainability Metrics Tool and Financial Modeling Tool.

Modeling to pull the project together via iterations between the energy (eQUEST) and financial (spreadsheet) models included several global energy and financial assumptions:

- Base case fuel escalation = 1%
- Base case construction escalation = 2.5%
- Base case inflation = 2%
- Base case real discount rate = 8%
- Base case green rent premium = 1%
- 15-year time horizon

The recommended strategy was called the "net present value midpoint" because it considered strategies based on a balance of NPV with the amount of carbon dioxide avoided. The NPV midpoint was compared with other options, including one that would maximize NPV, and another that would maximize carbon dioxide reductions regardless of NPV. Comparing the midpoint option to the two extremes would help identify best-case scenarios.

The results pointed to a clear solution: The team should pursue a program that would reduce energy use and greenhouse gas emissions by 38 percent, saving 105,000 metric tons of carbon dioxide over the next 15 years. Once all eight projects are complete, we project that the Empire State Building will achieve an ENERGY STAR score of 90, performing better than 90% of buildings in America regardless of age.

With these results in hand the team then ran an additional series of iterations through the models using various carbon trading proposals in the US, and the European Union OTC Carbon Price to gauge the effects carbon legislation could have on this project. The results showed significant differences when using the European framework, which increased NPV across the options, and from a business standpoint all other conditions remaining the same including ROI, more efficiency measures would be included with a corresponding increase in carbon savings.

"Achieving an energy reduction greater than 38 percent appears to be cost-prohibitive," the team noted in its final report to ownership. The analysis had examined strategies that could have reduced emissions by nearly 45 percent, out of a theoretical maximum of 55 percent. A total of 40 energy-efficiency ideas were narrowed down to 17 implementable strategies that were analyzed in depth. Of these, the first 90 percent of reduced carbon dioxide would also save costs over

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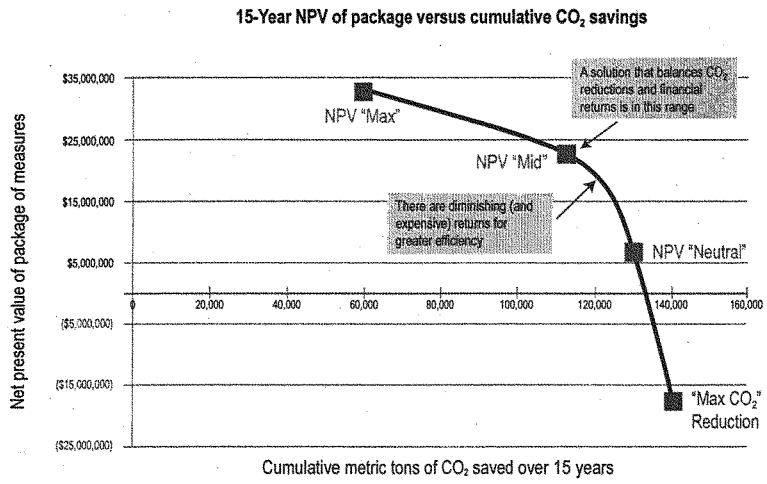
Empire State Building can achieve a high level of CO_2 and energy reduction cost-effectively



time by an average $200 per ton of carbon saved. The last 10 percent, by contrast, would carry a life cycle cost of more than $300 per ton of carbon saved.

Carbon dioxide reduction

The greatest reduction in carbon dioxide from the baseline would come from completing the task of installing digital demand controls that had been started in the capital projects. This strategy alone would reduce energy use by nine percent from the baseline. Tenant daylighting—working with tenants to ensure that layouts maximize the use of natural light—would save six percent from the baseline. Three other strategies would save five percent each: replacing constant volume air handling units with variable air volume units, retrofitting the chiller plant and addressing window glazing. Other strategies contributing to the 38-percent reduction included tenant energy management (three percent), radiative barrier (two percent) and tenant demand-controlled ventilation (two percent).

Chiller plant retrofit

The greatest cost savings came from the ability to retrofit the chiller plant rather than replace it. This was made possible by the reduction of the cooling load by 1,600 tons. The load reduction resulting from the sustainability program's demand control ventilation project, which reduces outside air infiltration, and the window light retrofit, which reduces solar heat gain, would allow the chiller plant to be updated rather than replaced entirely.

Peak electrical usage reduction

Under the proposed plan, peak electrical usage would also be reduced by 3.5 megawatts, from its current peak and capacity of 9.6 megawatts to just over six megawatts. At the same time, the team looked at several options for additional capacity, including co-generation, gas-fired generation, fuel cells, renewable energy and purchasing capacity. After analyzing all options, the team determined co-generation was actually unecessary because the energy savings initiatives eliminated the need for increased capacity.

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Enhanced tenant environment

In addition to reducing energy and carbon dioxide emissions, the proposed sustainability program would deliver an enhanced environment for tenants including improved air quality resulting from tenant demand-controlled ventilation; better lighting conditions that coordinate ambient and task lighting; and improved thermal comfort resulting from better windows, the radiative barrier and better controls.

The net present value of the midpoint option was estimated at $22 million over 15 years, compared with $32 million if NPV was maximized and negative $17 million if carbon dioxide reduced as much as possible regardless of NPV.

A key variable in the NPV calculation was the rent premium that could be gained from establishing the Empire State Building as a green building. The baseline calculation assumed that sustainable features would allow the building to gain rents one percent higher than if no such program were implemented. If in fact the sustainability program did not result in higher rent, the NPV over 15 years would be cut in half, to about $11 million. In its due diligence for making the calculation, the team identified key studies from CoStar Group, University of California-Berkeley and the University of Reading, which estimated the rent premium for green buildings between three and nine percent compared with similar buildings without those features. If the Empire State Building were to achieve the low end of this estimated spectrum by gaining a three-percent average rent premium, the 15-year NPV would be greater than $40 million.

Rocky Mountain Institute examined the impacts of potential miscalculation of energy savings, and found that the impact on NPV was fairly small. If energy savings were to fall short of the estimate by 20 percent, or exceed the estimate by 20 percent, the impact on NPV would be less than $3 million over 15 years. The impact of energy variance on CO_2 emissions, however, could be substantial. If the baseline estimate were to be met, the proposed initiative would save about 115,000 metric tons of CO_2 emissions over 15 years. If performance fell short of the estimate by 20 percent, CO_2 emissions would be less than 95,000 metric tons; if performance exceeded the estimate by 20 percent, more than 135,000 metric tons of CO_2 would be saved.

The team looked at anticipated near-term changes in U.S. CO_2 costs and concluded that legislation likely would not significantly change CO_2 calculations. In addition to recommendations on which strategies to implement, the team had also examined the length of time it would take to implement various strategies. This was a significant consideration, because a key metric of each strategy was the payback period for capital invested. If a strategy with a relatively short payback period required a long period of time to implement, that would affect the cost-benefit equation for that strategy. Under the proposed plan, 54 percent of the energy savings were part of a program that Johnson Controls would implement quickly. Another 22 percent of the savings would come from two projects that the Empire State Building Company would implement over several years: the tenant energy management program, and the installation of two variable air volume air handling units on each floor. The other 17 percent of energy savings would depend on tenant actions that would not be fully complete for 12 years as leases rolled over, a front-loaded process given that 40 percent of leases are set to expire over the next four years.

Tenant participation to drive energy savings

In order to capture the 17 percent of energy savings involving tenant spaces, the Empire State Building team was given the responsibility for a program that would include both aggressive guidelines and incentives for tenants to achieve energy savings of about six percent. Since nearly 40 percent of the building's leased space was due to turn over within four years, the team emphasized immediate adoption of guidelines for tenant improvements. The proposed green pre-built design would help the team establish design principles for all tenant spaces. Tenants could review the experience of the pre-built spaces and access the eQUEST model and tenant financial tool to verify the economic validity of the guidelines in terms of cost (estimated at $6 per square foot) and operational cost savings to the tenant ($0.70 to $0.90 per square foot annually).

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A program of sub-metering all tenant spaces and management of a reporting tool to inform tenants of their energy use was considered essential both to drive tenant focus on energy efficiency within their own space and to assist tenants in calculating their carbon footprints. Sub-metering would encourage tenants to follow the building guidelines on recommended strategies such as daylighting (creating space plans that maximize the use of natural light), and use of efficient lighting techniques such as task lighting.

The team also recommended exploration of tenant incentive programs such as a "feebate" plan wherein tenants that missed sustainability targets would pay fees that might be redistributed to those that exceeded sustainability targets.

Implementation of the eight projects began in April 2009 with the work scheduled to be completed in two phases. Building systems work to be finished by year-end 2010 will result in over 50 percent of the projected savings. The work to take place in tenant spaces will be completed by 2013 and will achieve the balance of the energy savings.

Key lessons learned

In summary, the final presentation to management reviewed some key lessons from the team's collective experience:

Developing robust solutions requires dynamic, multi-year models and collaborative efforts. The implementation team would need to anticipate and address changes in tenant profiles, vacancy rates and technology as well as building renovations and the possibility of tenant disruptions. Maintaining flexibility and collaboration in the team would ensure the success of the program.

Delivering the maximum cost-effective CO_2 reduction requires a whole-system and life-cycle view. A proactive, long-term plan is required to maximize CO_2 and financial benefits. One reason is that the most cost-effective efficiency upgrades would have to be linked to major capital upgrade projects. In addition, the team's assessment showed that rapid acceleration of efficiency implementation produced significant extra cost without providing a similarly large benefit.

The results reinforce the need to address the natural tension between business value and CO_2 reductions. The scenario that maximized business value would avoid more than half of the CO_2 reduction opportunity. Even the recommended program merely balanced cost and benefit at a point where the greatest benefit could be achieved for the lowest cost, rather than pursuing every viable CO_2 reduction measure without regard to cost. In order to make the business case, perceived needs and industry norms needed to align with energy-efficiency levers.

Rapid dissemination and adoption of the results requires development of an efficient process to reduce time and costs. To drive speed and effectiveness, the team recommended development and use of tools to diagnose and categorize a portfolio of buildings; to rapidly develop a "first cut" answer; and to navigate through the iterative process between energy and financial modeling at the project level.

Empire State Building Company accepted the team's proposed solution in its entirety (final project scope TBD), allowing the team to move forward immediately on implementation. The thorough and collaborative process had resulted in a strong consensus backed by transparent information. Tools were developed to measure and give feedback on building-wide and tenant improvements. The team now had a mandate and a plan to move forward swiftly and with confidence that the framework for decisions would continue to yield positive results, ultimately serving the goals of the Empire State Building owners and tenants as well as overall environmental goals.

A look forward

The analytical process was merely the first step toward achieving an optimal energy and sustainability profile at the Empire State Building, but it was of critical importance to the ultimate success of the program. The strategies selected from this process will not only have a significant impact on the building's carbon footprint but will open doors to additional cost-effective avenues of financing the project.

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The Empire State Building is just one drop in an ocean of commercial buildings that must undergo some form of rational energy and sustainability retrofit in the next several years if we as a society are committed to reducing the impact of buildings on the environment. It is hoped that by making available documentation and information such as this report, the Empire State Building sustainability team can clear a path for thousands of other buildings to follow.

For more information on the energy efficiency retrofit project at the Empire State Building, contact:

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The Empire State Building

Repositioning an Icon as a Model for Energy Efficient Investment

JONES LANG LASALLE®

Real value in a changing world

CLINTON FOUNDATION

CLINTON CLIMATE INITIATIVE

Rocky Mountain Institute

Johnson Controls

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Motivation

"The goal with ESB has been to define intelligent choices which will either save money, spend the same money more efficiently, or spend additional sums for which there is reasonable payback through savings. Addressing these investments correctly creates a competitive advantage for owners through lower costs and better work environment for tenants. Succeeding in these efforts has made a replicable model for others to follow, and a chance to inform policy with good practice."

- Anthony E. Malkin
Malkin Holdings

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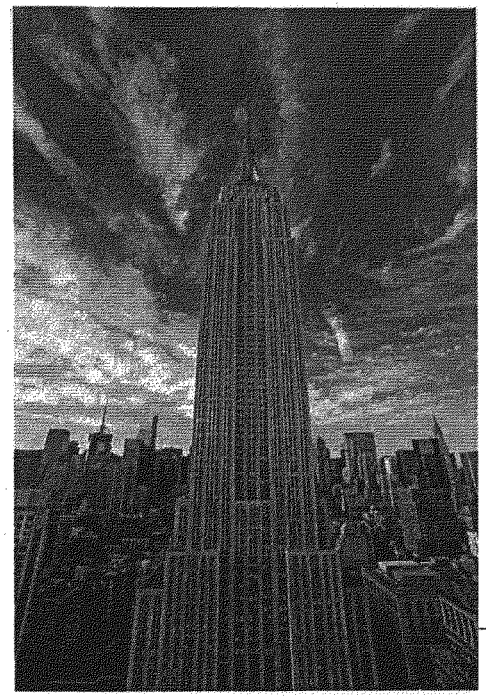
The Empire State Building

Demonstrate the business case for cost effective energy efficient retrofits through verifiable operating costs reductions and payback analysis



102 stories and **2.8 million** square feet

4.0 million visitors per year

$11 million in annual energy costs

Peak **electric** demand of **9.5 MW** down from 11.6 (3.8 W/sf incl. HVAC)

88 kBtu per sf per yr for the office building

CO_2 emissions of **25,000 tons** per year (22 lbs/sqft)

3

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Motivation

The retrofit of the Empire State Building was motivated by the building ownership's desire to:

1) Reposition the world's most famous office building into a pre-war trophy asset
2) Prove or disprove energy efficiency retrofits' economic viability
3) Use our work to publicize and differentiate our building and attract tenants
4) Produce a replicable model for energy efficiency retrofits of existing buildings, which will make up 85% of buildings in place in New York City in 2030
5) "If the only place we succeed is ESB, the effort is a failure."

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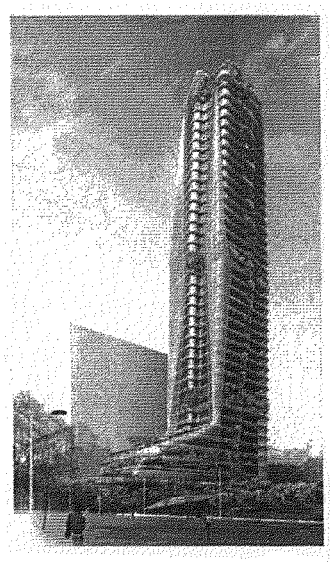
"Green" vs. Energy Efficient Retrofits

Green building practices include energy efficiency.
Energy efficient retrofits focus on quantifiable energy efficiency measures.

Green Building Practices

- Renewable, recycled-content, reused and locally produced materials
- Indoor air quality (voc-free materials, DCV)
- Recycling programs
- Water reduction
- Green cleaning
- Green pest management



Energy Efficient Retrofits

- ✓ Reduce loads
- ✓ Reduce energy usage
- ✓ Optimize systems efficiency
- ✓ Provide controls
- ✓ Integrated, lifecycle approach
- ✓ Quantifiable metrics
- ✓ Guaranteed savings
- ✓ Measurable payback and return on investment

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Industry drivers for energy efficient retrofits

Converging forces

Recognition of need to develop more sustainable and efficient business practices

Acceptance of energy supply constraints and national security issues posed by energy dependence

Ongoing federal, state and local legislative action

Corporate trend toward GRI reporting, self regulation and reduction in GHG emissions

Customer, employee and shareholder pressures

Business opportunity

Growing pressure to alter appraisals, values for lending and purchasing based on sustainability

Reduced operating costs through efficiency

Increased marketability, competitiveness

Improved work environments, productivity, recruitment and retention

Positive NPV and ROI

Fund improvements through energy savings

Maintain value

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Create a replicable model

Demonstrate how to cost-effectively retrofit a large multi-tenant office building to inspire others to embark on integrated energy efficiency retrofits.

1 Identify opportunities

- 60+ energy efficiency ideas were narrowed to 17 implementable projects
- Team estimated theoretical minimum energy use
- Developed eQUEST energy model

2 Evaluate measures

- Net present value
- Greenhouse gas savings
- Dollar to metric ton of carbon reduced
- Calculated for each measure

3 Create packages

- Maximize net present value
- Balance net present value and CO_2 savings
- Maximize CO_2 savings for a zero net present value
- Maximize CO_2 savings

4 Model iteratively

- Iterative energy and financial modeling process to identify final eighht recommendations

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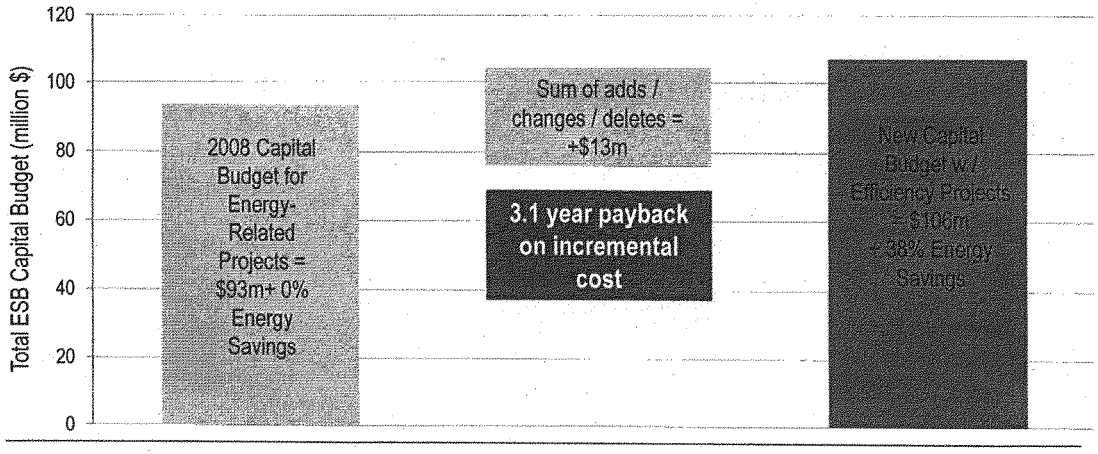
Demonstrate business case through verifiable operating costs reductions and payback analysis

With a $550 million capital improvement program underway, ownership decided to re-evaluate certain projects with cost-effective energy efficiency and sustainability opportunities in mind.

Capital Budget Adjustments for Energy Efficiency Projects



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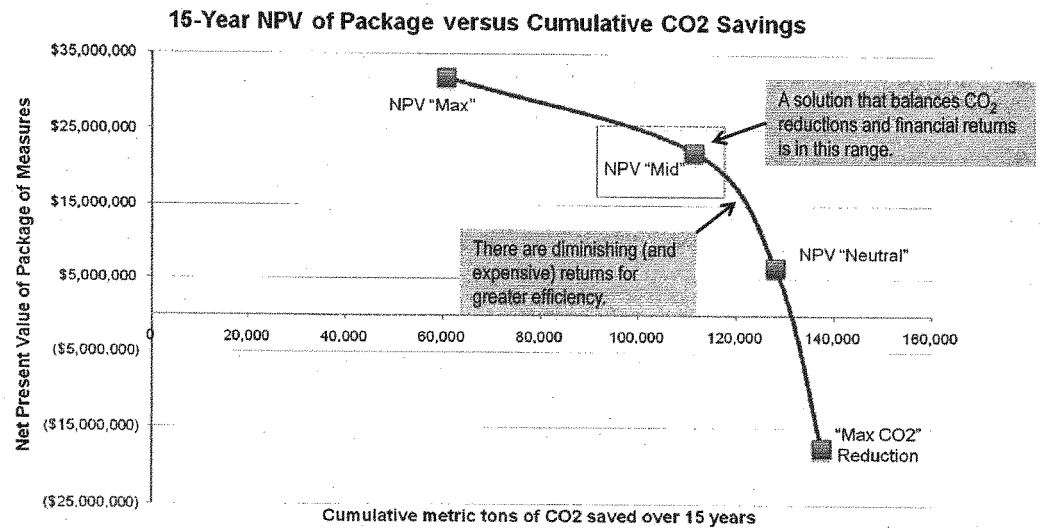
Balance financial return & carbon reduction

ESB can achieve a high level of CO_2 and energy reduction cost-effectively



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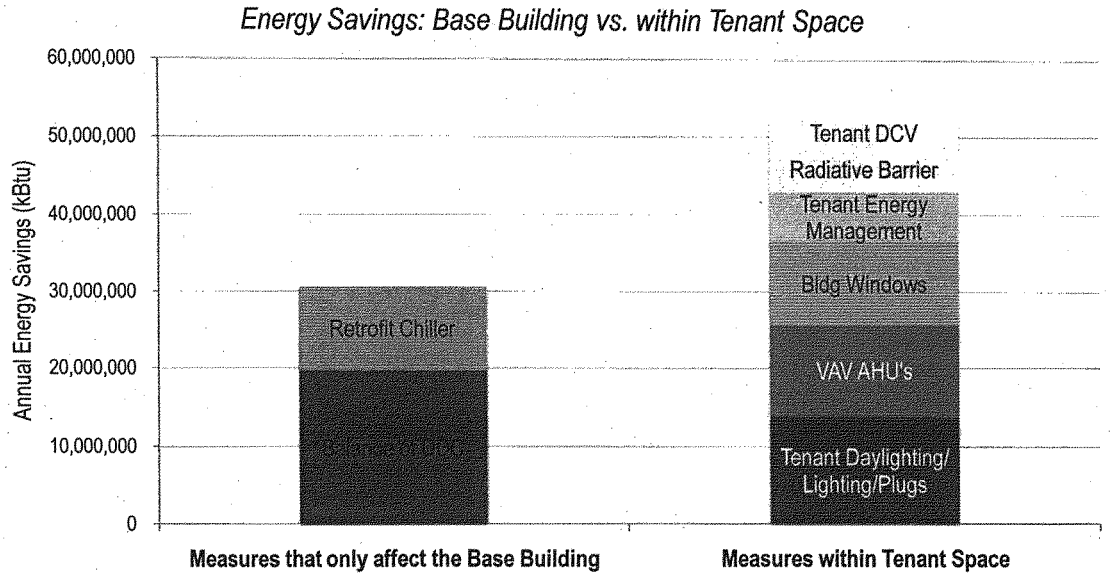
The business case – integrated approach

More than half the savings exist within tenant spaces



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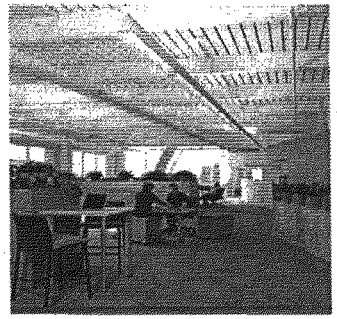
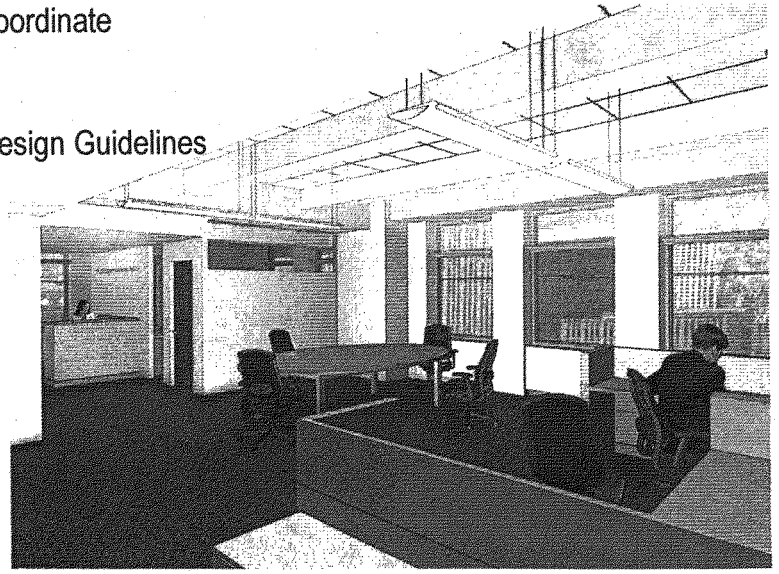
Tenant Spaces

Enhanced work environments are created

- Better thermal comfort resulting from better windows, radiative barrier, and better controls;
- Improved indoor air quality resulting from DCV; and
- Better lighting conditions that coordinate ambient and task lighting.
- Positive ROI
- Tenant Prebuilt Program and Design Guidelines





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Savings in Tenant Spaces

Investments based on incremental cost and projected savings

	Total Project Cost	Total Cost ($/rsf)	Construction Cost ($/rsf)
Class 'A' Office Budget	$4,413,404	$180.88	$121.45
Actual Costs	$4,624,262	$189.52	$132.95
LEED Premium & Energy Efficiency*	$210,858	**$8.64**	**$11.50**
*Total LEED Premium – 4.7%			
Energy Saving (NPV for 15 Yrs)	$593,496		
NYSERDA Grant (Approx.)	$22,802		
Net Positive**	$405,440		
**Total Savings – 9.2%			

Data provided by Skanska based on performance of their 32nd floor office at the ESB, 2009

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Measured and Verified Energy Savings

Utility Consumption Comparison

136 Madison Avenue
(Class "A" Office)

	2008					Total Annual Actual	Comparison Annual Adjusted*
	JAN Actual	FEB Actual	MAR Actual	APR Actual	MAY Actual		
Cost	$3,677	$3,921	$4,209	$3,721	$4,905	$57,506	$85,039
Consumption (KWH)	13,760	15,520	17,920	14,880	19,893	220,853	326,595
Avg. Cost per KWH	0.27	0.25	0.23	0.25	0.25	0.26	0.26
Energy Cost (Per Rentable Square Feet)	0.22	0.24	0.26	0.23	0.30	3.49	3.49

Empire State Building
(LEED Platinum)

	2009					Total Annual Projected	ESB LEED* Office Annual Adjusted**
	JAN Actual	FEB Actual	MAR Actual	APR Actual	MAY Actual		
Cost	$1,989	$1,987	$2,500	$2,151	$2,525	$32,015	$43,099
Consumption (KWH)	10,516	10,506	11,686	10,523	12,220	165,764	165,764
Avg. Cost per KWH	0.19	0.19	0.21	0.20	0.21	0.19	0.26
Energy Cost (Per Rentable Square Feet)	0.08	0.08	0.10	0.09	0.10	1.31	1.77

49%
Energy Savings

Data provided by Skanska based on performance of their 32nd floor office at the ESB, 2009

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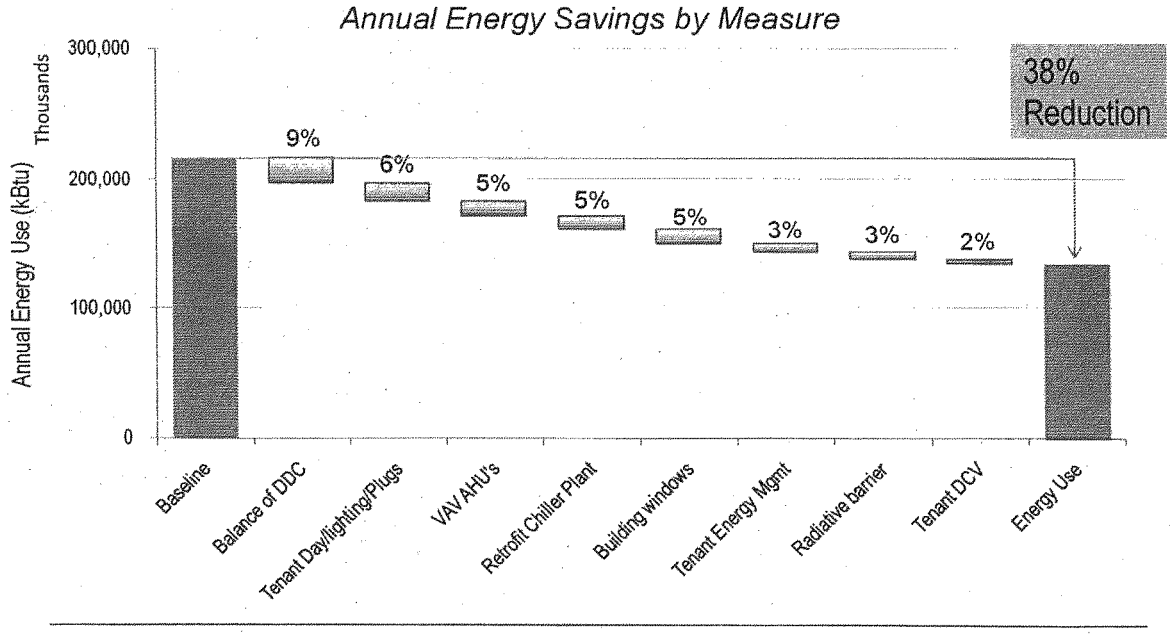
Implementing recommended measures

Eight interactive levers chosen iteratively from more than 60 options ranging from base building measures to tenant engagement deliver these results



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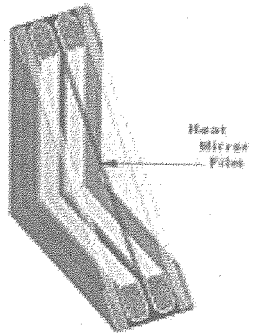
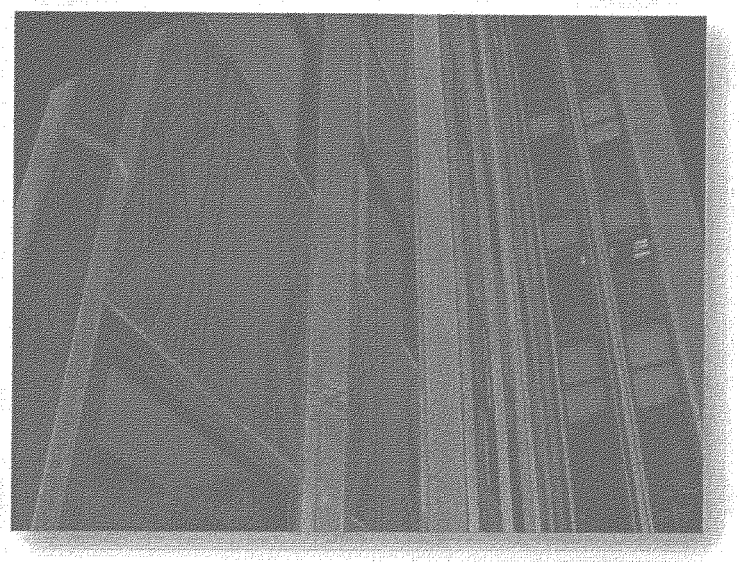
Measures

WINDOWS: Remanufacture existing insulated glass units (IGU) within the Empire State Building's approximately 6,500 double-hung windows to include suspended coated film and gas fill.





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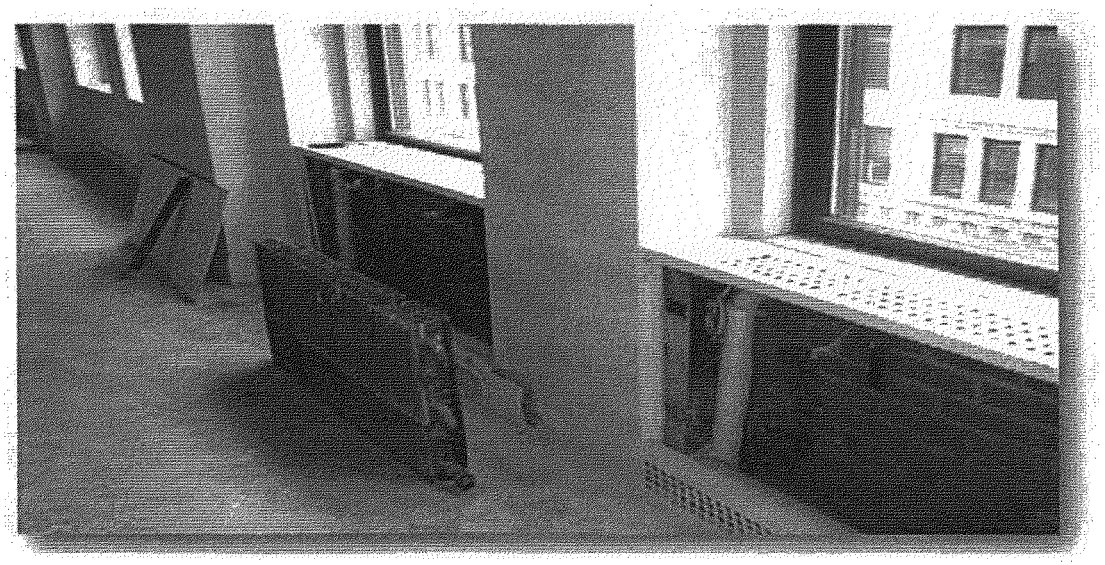
Measures

RADIATIVE BARRIER: Install more than six-thousand insulated reflective barriers behind radiator units located on the perimeter of the building.



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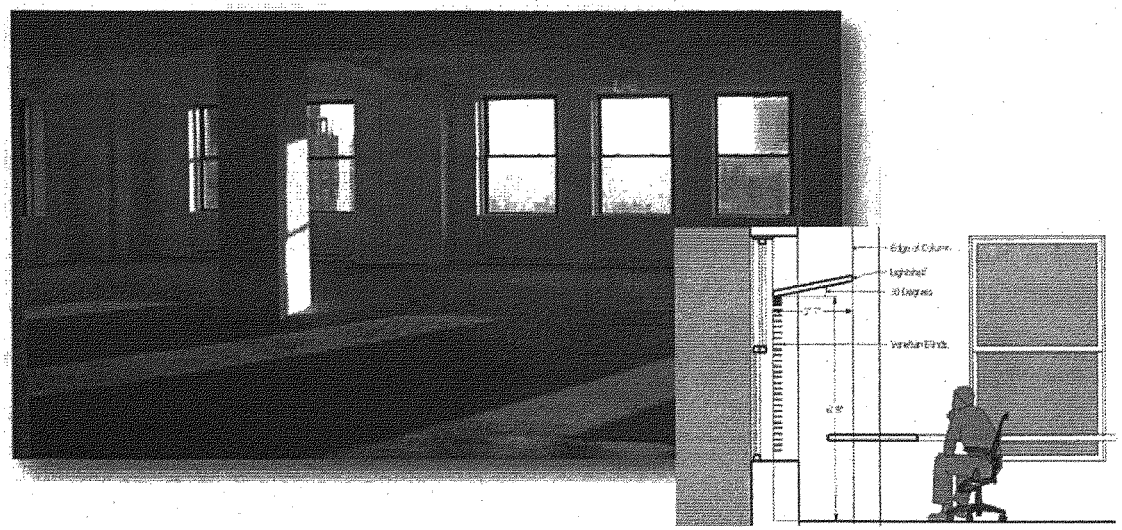
Measures

TENANT DAYLIGHTING / LIGHTING / PLUGS: This measure involves reducing lighting power density in tenant spaces, installing dimmable ballasts and photosensors for perimeter spaces, and providing occupants with a plug load occupancy sensor for their personal workstation.



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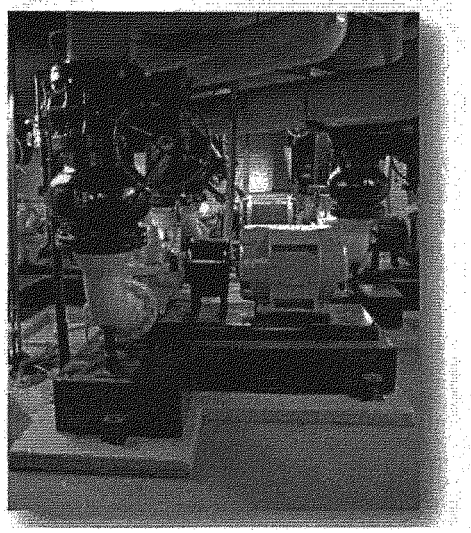
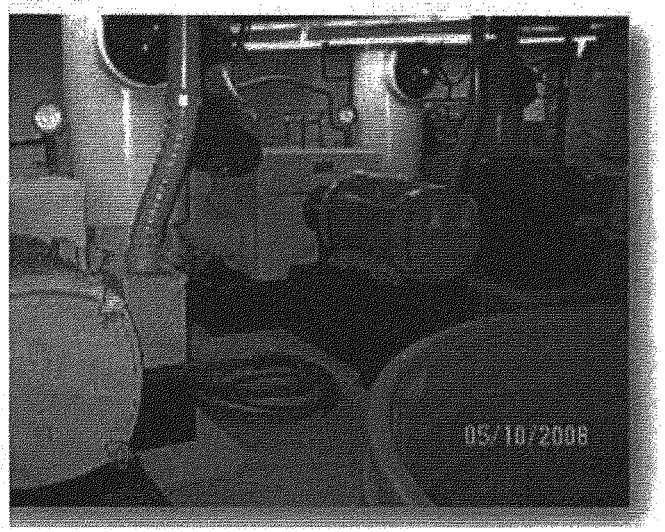
Measures

CHILLER PLANT RETROFIT: The chiller plant retrofit project includes the retrofit of four industrial electric chillers in addition to upgrades to controls, variable speed drives, and primary loop bypasses.





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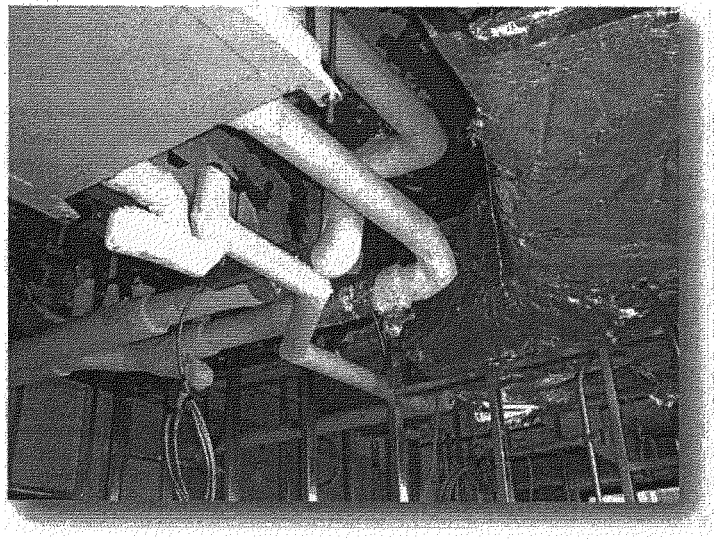
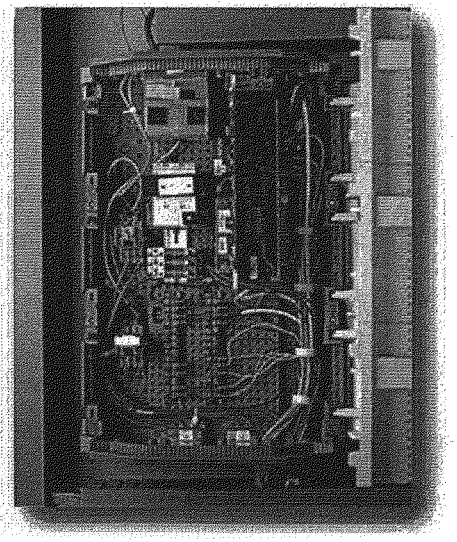
Measures

VAV AIR HANDLING UNITS: Replace existing constant volume units with variable air volume units using a new air handling layout (two floor-mounted units per floor instead of four ceiling-hung units).





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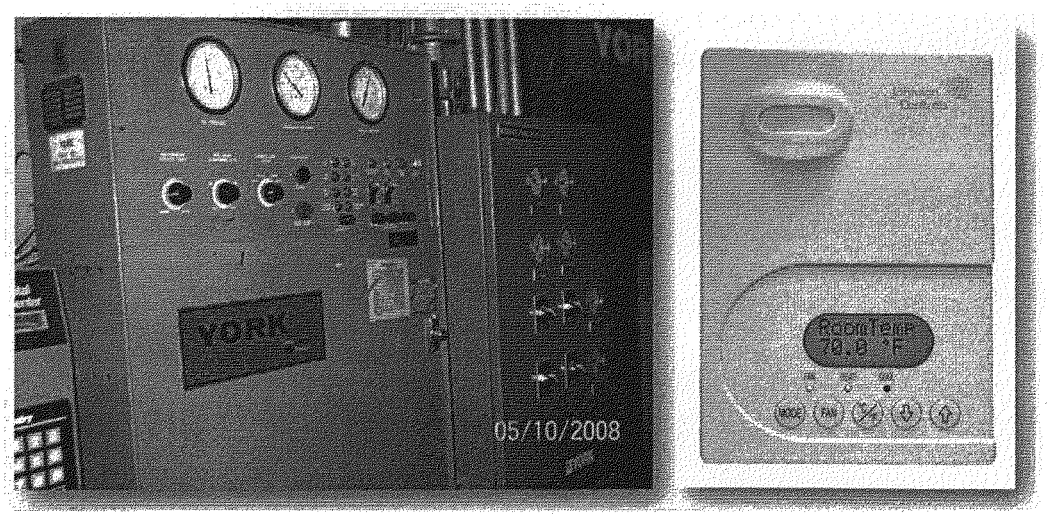
Measures

DDC CONTROLS: The measure involves upgrading the existing control systems at the Empire State Building becoming ***one of the largest wireless networks ever installed***.

Real-time ***facilities performance index monitoring*** used for continuous commissioning of HVAC systems.



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Measures

DEMAND CONTROL VENTILATION: This project involves the installation of CO2 sensors for control of outside air introduction to chiller water and DX Air Handling Units.

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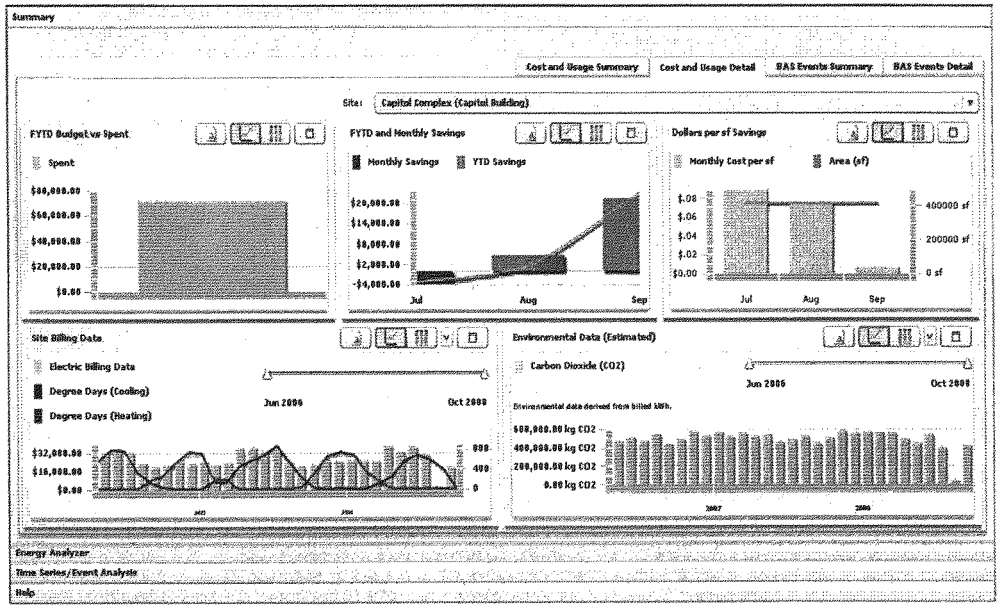
Measures

TENANT ENERGY MANAGEMENT: This project will provide tenants with access to online energy consumption and benchmarking information as well as sustainability tips and updates.



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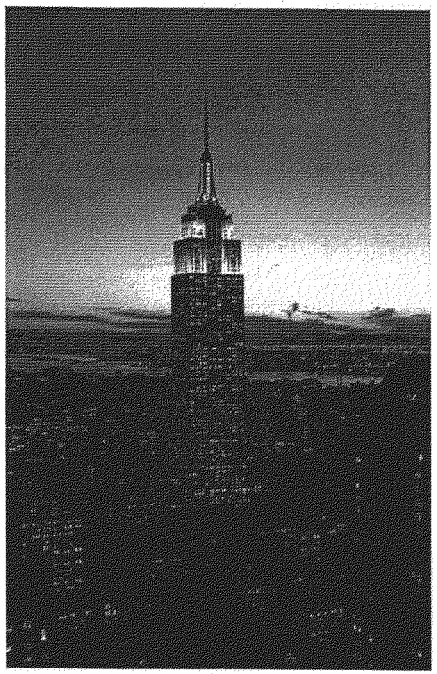
Challenges



- Full exploration of all energy efficiency measure can be time consuming and resource intensive
- Realizing maximum impact requires the engagement and participation of all of the building stakeholders and skilled execution
- Important energy efficiency measures had to be passed over to maintain a sub-five year payback
- Financing should be a combination of financing savings and incentives which take into account expenditures avoided due to reductions in energy consumption
- Many buildings are subscale for large ESCO programs
- Resource limitations are a governor of speed and breadth

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Practical Next steps

What you can do to take action

1) Triage your building portfolio based on renovation cycle
2) Create a sustainability master plan including retrofit projects, design standards, lease structure changes, tenant energy management programs, and marketing initiatives
3) Commit to an integrated, whole-building retrofit approach: Conduct whole-building audits rather than single measure projects
4) Require performance guarantees with ongoing measurement and verification of savings to reduce risk and maintain performance
5) Engage tenants, employees, and building occupants in energy savings efforts through training, tools, technology
6) Create concrete successes at the building and pre-built level to build momentum and enthusiasm

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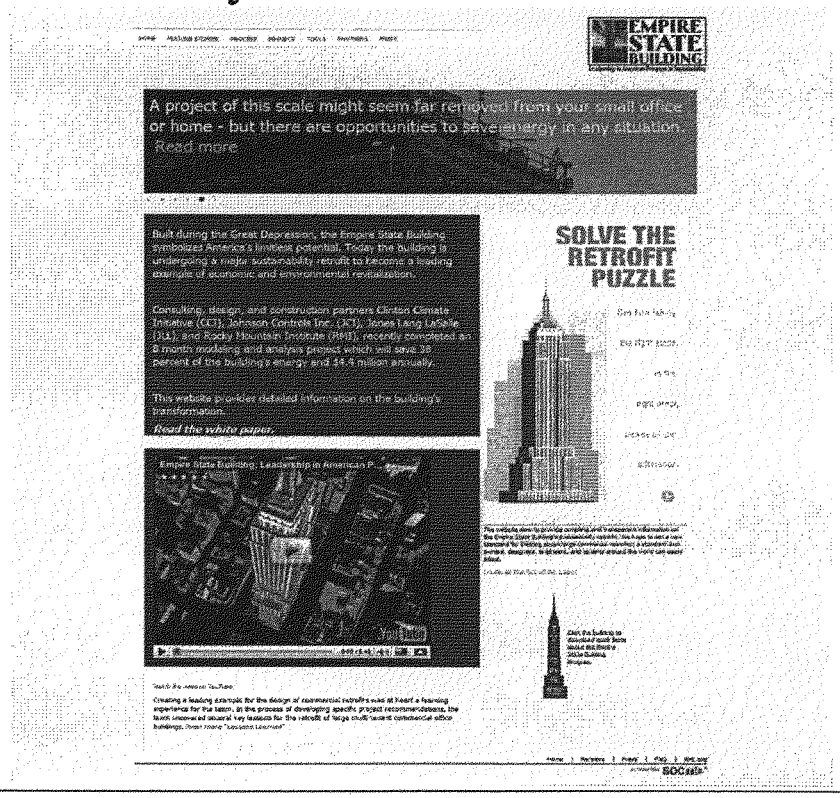
www.esbsustainability.com



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The Importance of Research and Development (R&D) for U.S. Competitiveness and a Clean Energy Future

Michael Greenstone
3M Professor of Economics, MIT
Director, The Hamilton Project
Senior Fellow, The Brookings Institution

Thank you Chair Maloney, Ranking Member Brownback and members of the Committee for inviting me to testify today. I believe it is critically important that we give greater priority to new and better research and development (R&D) investments, to help ensure our country's future competitiveness and to pave the wave for clean energy innovation.

I am grateful for the opportunity to speak today about two interrelated challenges that our country faces. The first is the stagnation in economic opportunity for many families that dates back at least three decades. The second is the economic, national security, and environmental risks posed by our continued reliance on fossil fuels. The key purpose of my testimony is to discuss how R&D can enable us to begin confronting these dual challenges by creating new jobs for American workers, and fundamentally altering the way we produce and consume energy.

I. CHALLENGE 1: UNITED STATES COMPETITIVENESS

Even before the Great Recession's arrival, there were legitimate concerns about U.S. competitiveness. A recent study by my colleague David Autor, a professor at MIT, highlights the fact that since the 1980s, the American job market has become polarized between high-skilled, high-wage jobs and low-wage, low-skilled jobs. At the lower end of the labor market wages have stagnated or declined. Between 1979 and 2007, real earnings for high school graduates with no further education declined by 12%, and earnings for high school dropouts declined by 16%.[1] During the same period, earnings for those with a college degree or better have increased by 10% to 37%.

At the same time, male labor force participation rates declined between 1979 and 2007 for all education levels, but especially among less-educated men. Employment to population ratios for high school dropouts and graduates declined by 12% and 10% respectively.[2] In many cases, this detachment from the labor force reflects a judgment that individuals cannot earn enough to support their families.

The economic impact of this wage stagnation has been compounded by reduced rates of increases in educational attainment. Thus, at the same time that the market was sending a message about the increased importance of skills, the rate of increase of accumulation of skills

[1] David Autor, "The Polarization of Job Opportunities in the U.S. Labor Market," Hamilton Project and Center for American Progress Joint Paper, April 2010, pp. 3-6.
[2] Autor, 20.

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was declining. (Women are an important exception as their college completion rates increased dramatically in this period.)[3]

The troubling trends are also evident in our ability to compete in international markets. Our world market share of exports produced by high technology industries dropped from 20% to 12% between the 1990s and 2005. In contrast, from 1999 to 2005, China's market share has more than doubled from 8% to 19%. Additionally, the U.S. trade balance in advanced technology products shifted from a surplus to a deficit in 2002.[4]

These trends threaten the social fabric of our nation. A defining feature of our history is that each generation of American has enjoyed a higher standard of living and has had access to opportunities that were not available to their parents. This pattern of advancement is under assault. For our political and economic systems to work well, it is vital that all Americans feel that they are able to participate in our nation's economic growth. Indeed, one of The Hamilton Project's (an economic policy group at Brookings that I direct) core principles is that economic growth is stronger and more sustainable when it is broad based.

II. CHALLENGE 2: FOSSIL FUEL DEPENDENCE, ENERGY SECURITY, AND CLIMATE CHANGE

The United States and the world rely on the Persian Gulf countries for petroleum. This region is not always politically stable and can be hostile to our interests. Thus, our need for access to reliable and affordable petroleum constrains our foreign policy objectives, especially our national security ones. This is the essence of our energy security challenge.

At the same time, climate scientists tell us that the warming of the climate is unequivocal, and "very likely" due to increases in greenhouse gas concentrations from burning of fossil fuels, such as petroleum.[5] Indeed without a change in policy, the state of the art climate models predict that the mean global temperature will increase by more than 7 degrees Fahrenheit over the course of this century.[6]

In addition, the models predict a startlingly large increase in the number of very hot days. For example, one model predicts that by the end of the century the typical person in the United States is predicted to experience 31 additional days where the mean daily temperature exceeds 90° F.[7] Currently, the typical person experiences just 1.3 days per year where the mean

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[3] Autor, 25.

[4] National Science Foundation, Chapter 6: Industry, Technology, and the Global Marketplace in *Science and Engineering Indicators 2008* (2008).

[5] Intergovernmental Panel on Climate Change (IPCC). "Climate Change 2007: Synthesis Report, Summary for Policy Makers," (2007). The IPCC defines "very likely" as at least 90% certain.

[6] Congressional Budget Office. "Potential Impacts of Climate Change in the United States," (Pub. No. 3044, May 2009), p. 7

[7] For example, a day with a high of 100° F would need a minimum temperature greater than 80° F to qualify.

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exceeds 90° F. To be clear, a day with a mean temperature exceeding 90° F is very hot because the mean daily temperature is calculated as the average of the high and the low.[8]

There are likely to be other changes in climate, including higher sea levels, changes in rainfall patterns, and increased storm intensity. The consequences of climate change for health, economic growth, innovation, and well-being are not well understood, but include quite negative possibilities.[9]

Further, two interrelated factors increase the odds that such dramatic changes in temperature will occur. First, fossil fuels, like coal and petroleum, are the cheapest sources of energy available today. Additionally, there appear to be bountiful supplies of fossil fuels -- meaning that they are likely to remain inexpensive. At our current consumption level, there are more than 245 years worth of proven coal supplies in the United States.[10] There are also large reserves in India and China, where much of the increase in future demand for energy is projected to occur.[11]

The second factor is that a substantial share of the world's population remains very poor. These economies are likely to pursue cheap energy sources as they grow in the coming decades. Indeed, for the leaders of these nations, pulling their citizens out of poverty is a policy priority that exceeds reducing greenhouse gas emissions in importance.

Some basic statistics help to underscore why developing countries will be focused on growth. Today, per capita income is about $46,000 in the United States. In China and India, it is $6,500 and $3,100, respectively.[12] These differences in income have consequential impacts on people's lives. India's infant mortality rate is nearly eight times higher than the U.S. rate. The China infant mortality rate is three times higher than ours.[13]

The bottom line is that for a substantial period of time, developing countries are likely to be focused on increasing their incomes and using the cheapest energy sources available to do so. Without a change in the cost of low carbon fuels, this will mean increased demand for fossil fuels. In fact, the latest reference case projections from the U.S. Energy Information Administration reveals that non-OECD countries will increase their CO_2 emissions from 14.7

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[8] Olivier Deschenes and Michael Greenstone. "Climate Change, Mortality, and Adaptation: Evidence from Annual Fluctuations in Weather in the U.S." (MIT Joint Program on the Science and Policy of Global Change, 2007).
[9] Olivier Deschenes and Michael Greenstone. "Climate Change, Mortality, and Adaptation: Evidence from Annual Fluctuations in Weather in the U.S." (MIT Joint Program on the Science and Policy of Global Change, 2007).
[10] BP, "BP Statistical Review of World Energy," (June 2010).
[11] Due to the peculiarities of how proven reserves are calculated in the energy industry, my expectation is that current estimates of reserves are underestimates of the total reserves of coal and petroleum. In particular, proven reserves are frequently calculated at current prices and thus do not reflect the likely increase in reserves at higher prices.
[12] Central Intelligence Agency, "The World Factbook."
[13] World Health Organization, "World Health Statistics 2010," (2010).

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billion metric tons in 2007 to 28.2 billion metric tons in 2035.[14] As a point of comparison, U.S. emissions are projected to increase to 6.3 billion metric tons of CO_2 in 2035 from 6.0 billion metric tons in 2007.

III. WHAT IS THE CONNECTION?

Why are these challenges -- U.S competitiveness and fossil fuel dependence-- connected?

The need to find new sources of energy that do not constrain our foreign policy objectives nor imperil our planet is real and will not go away without significant breakthroughs in energy innovation.

This creates an opportunity for the countries, firms, and workers that can provide a solution. Specifically, the innovators that reduce the cost of low carbon energy sources or otherwise reduce the build-up of greenhouse gas concentrations will be able to sell the technologies and equipment to countries around the world. This will produce new industries and jobs and could be an important part of strengthening future U.S. competitiveness.

The tough question is how to get from here to there.

IV. A NEW AND IMPROVED ENERGY R&D SYSTEM AS A SOLUTION

I believe that the solution lies in undertaking a new program of energy R&D that is narrowly focused on funding research that the private sector will not undertake. Further, such a new R&D program must have higher levels of investment than we have seen in recent years.

A. Why is R&D so Important?

Let me provide some brief background on the historical importance of R&D. It has been apparent for at least a century that future economic progress will be driven by the invention and application of new technologies. R&D is one category of spending that develops and drives these new technologies. However, private sector firms are prone to focus their R&D on "applied" projects, where the payoff to their bottom line is likely to accrue only to them. Their role is not to undertake broad R&D for the general benefit of our nation.

In contrast, government can sponsor the kind of "basic" research projects that seek wide-ranging scientific understanding that can affect entire industries, rather than individual firms. For example, government research funding has been critical to many technologies of everyday importance. Just a few examples would include the development of plant genetics, fiber optics, magnetic resonance imaging, computer-aided design and computer-aided manufacturing (CAD/CAM), data compression technologies that make all manner of electronic devices more

[14] Energy Information Agency, Appendix A: Reference Case Scenario in *International Energy Outlook,* (May 25, 2010), p. 13

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powerful, progress toward edible vaccinations, and the "eye chip" that might help 6 million blind Americans see.[15]

From the perspective of U.S. competiveness, many of these government-sponsored technological advances have been instrumental in driving economic growth and raising living standards for American families. They have created new industries and high paying jobs that have benefitted a wide-range of regional, state, and local economies.

B. An Abridged History of the Track Record of U.S. R&D Funding

Two of the most notable vehicles for supporting R&D in the United States are the National Institutes of Health (NIH) and the National Science Foundation (NSF). They both have impressive track records that you may already be familiar with.

The National Institutes of Health is funded at about $30 billion per year through the federal budget. This constitutes around 75% of global spending in basic medical science. The NIH has been instrumental in keeping the United States at the forefront of medical innovation: NIH-funded scientists have won 93 Nobel Prizes, and 15 of the 21 most important new drugs between 1965 and 1992 were developed using NIH-funded research.[16] A key to the NIH's continued success has been its internal funding process—while decisions on the establishments of new NIH Institutes and Centers are subject to outside budgetary approval, decisions on research funding within specific fields are made based on a competitive peer-review process.[17]

Another major U.S. success story in the field of basic research and R&D is the National Science Foundation. The NSF supports basic research in a variety of fields and also awards grants through a competitive peer review process. It had a budget of $6.49 billion in 2009. Basic research funded by the NSF has resulted in the development of a diverse set of technologies that have had significant impacts on both quality of life and economic growth, including American Sign Language, bar codes, Doppler Radar, and web browsers.[18]

The Government Accounting Office (GAO) has found that peer review scores at the NSF and the NIH were unrelated to any measured attributes of reviewers or applicants. This suggests that the quality of the proposal was the most important factor in peer reviewers scoring.[19] It seems reasonable to conclude that high levels of funding for basic research coupled with a competitive grant-allocation process played instrumental roles in the success of their R&D programs.

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[15] National Science Foundation, "NSF History: Nifty Fifty."
[16] Joint Economic Committee (Office of the Chairman, Connie Mack), "The Benefits of Medical Research and the Role of the NIH," (May 2000).
[17] U.K. National Endowment for Science Technology and the Arts, "Technology Policy and Global Warming: Why new policy models are needed," (October 2009), p 13.
[18] National Science Foundation, "NSF History: Nifty Fifty."
[19] General Accounting Office, "Peer Review: Reforms Needed to Ensure Fairness in Federal Agency Grant Selection," (GAO/PEMD-94-1, June 1994).

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In contrast, the funding for energy research has often been focused on the deployment of existing technologies, rather than the development of new products. In general, deployment of existing technologies is a task that is best left to the private sector. In the cases where the technology is cost competitive, the private sector will deploy it. In cases where the technology is not competitive, the private sector will not allocate resources to its deployment. Further, a lot of energy research is path dependent in that it follows the expertise of the Department of Energy (DOE) laboratories around the country, rather than the highest value added ideas. Finally in general, DOE funding decisions have not been as single mindedly based on peer review as is the case with the NIH and NSF.

The recent creation of the Advanced Research Projects Agency (ARPA-E) shows substantial promise.[20] It is modeled after the Defense Advanced Research Projects (DARPA) agency that led to significant technological breakthroughs including GPS. ARPA-E has worked to develop new technologies that offer progress toward reducing dependence on imported energy, reducing emissions, and increasing energy efficiency.[21] The 2011 budget allocated $300 million for the ARPA-E program, which is about 1% of the funding for the NIH and 5% of the funding for the NSF.

C. How Much Does the United States Spend on R&D?

Our commitment to funding R&D has flagged in recent years. The below chart reveals that the federal government's contribution to R&D spending as a share of GDP has been declining over the last several decades. At its peak during the Cold War, it was more than 2% but it has been on a steady decline and is now less than 1%.

[20] Congressional Research Service,"Energy Provisions in the American Recovery and Reinvestment Act of 2009," (March 3, 2009), p. 5.
[21] Department of Energy (Energy Efficiency and Renewable Energy), "DOE Launches the Advanced Research Projects Agency-Energy, or ARPA-E," (April 29, 2009).

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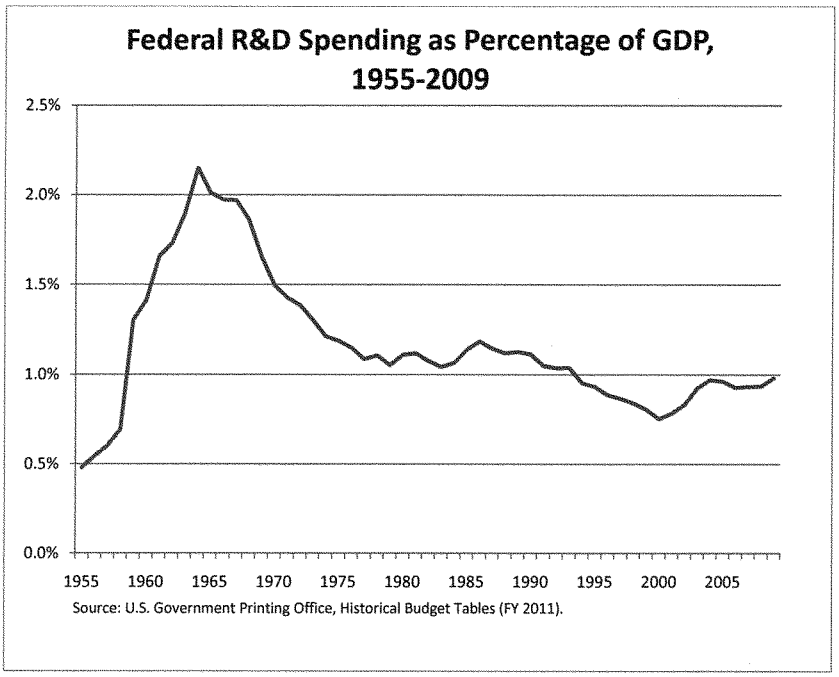

The next chart explores the time series of federal R&D in the energy sector. In 2009, federal R&D spending on energy totaled $1.7 billion or a little more than 1/100 of 1 percent of GDP. In constant dollar terms, this is less than one fourth of the peak in energy R&D spending during the 1980s. Alternatively, it is just 55% of the $3.1 billion that will be spent in 2011 providing a tax benefit for employee parking! As a percentage of GDP, it is 1/10 of the peak spending in 1979. [22]

[22] Moreover, private investments in energy R&D have been in decline for some time: energy R&D spending by U.S. companies fell by 50% or about $1 billion between 1991 and 2003. See Gregory Nemet, "U.S. Energy Research and Development: Declining Investment, Increasing Need, and the Feasibility of Expansion," (Doctoral Candidate at University of California, Berkeley, June 29, 2006), pp. 3-5.

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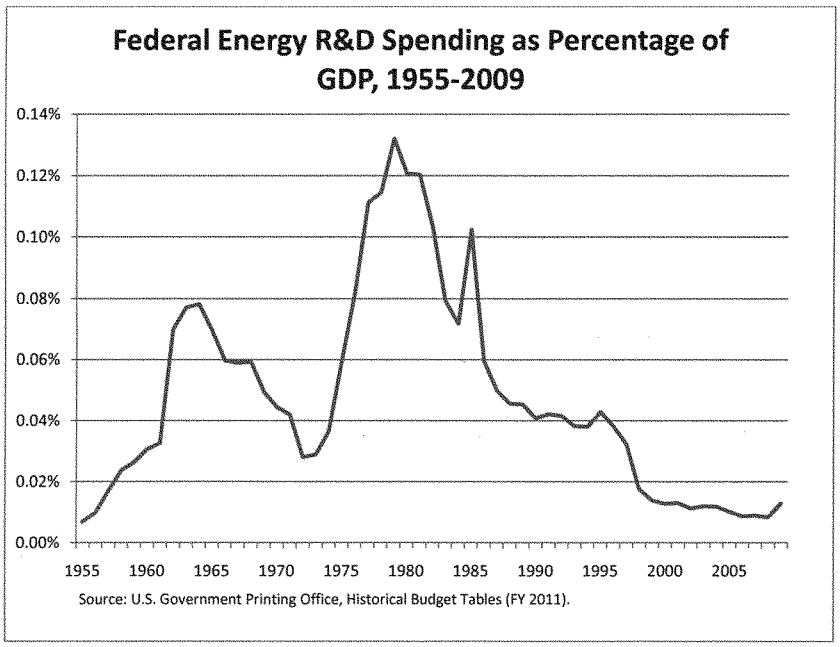

It is also instructive to compare U.S. spending with other countries. This comparison is if anything, even less favorable. During the 5 year period of 2004-2008, the average U.S. federal level of support of energy R&D was equal to about 0.0127% or about 1/100 of 1% of GDP according to OECD calculations.[23] This rate of investment in energy R&D puts the United States in 12th place out of the 12 OECD countries that spent the most on energy R&D during this period.

[23] OECD statistics on energy R&D include a broader set of outlays than do OMB figures.

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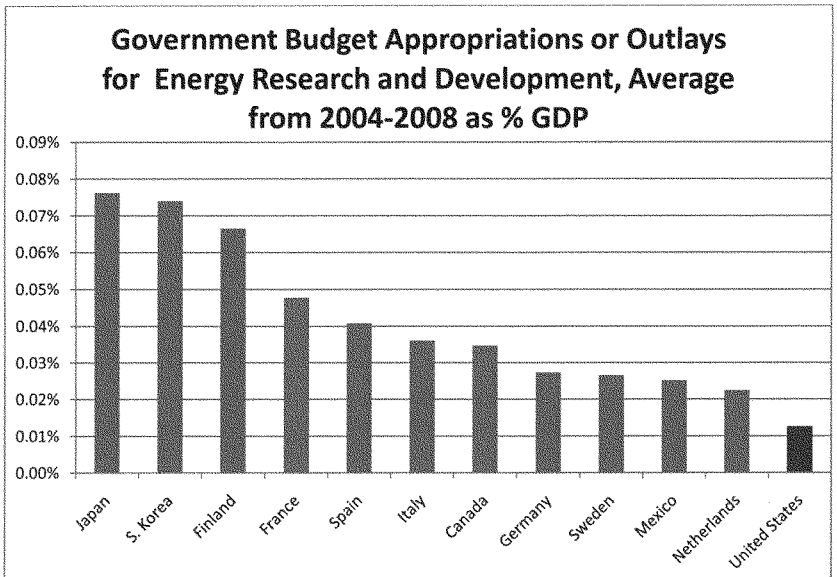

Source: OECD Government Budget Appropriations or Outlays for R&D (BAORD), Data by Socio-Economic Objective, expenditures on "Production, distribution and rational utilization of energy"
GDP from World Bank World Development Indicators.
Data not available for Canada 2008, Russian Fed. 2004-2006, Mexico 2007-2008.

The conclusion from these figures is simple: without greatly expanded investments in U.S. energy research and development, we will not be poised as a leader in energy innovation. This greatly decreases the chances that we will be able to reduce our dependence on fossil fuels and fundamentally decarbonize the U.S. energy sector. Further, it decreases the chances that the coming revolution in the energy sector will aid our global competitiveness.

D. Principles for Reform of U.S. Energy R&D Program

With this background, I would like to suggest some key principles for research and development that I think the United States should adopt moving forward -- with specific emphasis on energy R&D. Let me provide the caveat that these are broad themes and should be considered a starting point for future discussions on how to best structure an improved federal R&D program. The Hamilton Project is undertaking this challenge and is in the process of commissioning a series of "discussion papers" on this issue that will lay out specific policy proposals for enhancing our nation's R&D capacity. We will unveil this new thinking in 2011.

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As I see it, the evidence supports five key principles for R&D that could help transform our energy future:

1. *Increased funding*: Increasing federal energy R&D funding is necessary to stimulate the kind of innovations that we need to reduce our dependence on fossil fuels, increase our energy independence, mitigate the impacts of climate change, and increase our nation's competitiveness. The exact level of funding is a political judgment that must account for the other budget priorities, but it is clear that the current level is woefully inadequate.

2. *Political independence:* As the experiences of the NIH and the NSF demonstrate, one of the keys to a successful R&D policy is ensuring that funding is awarded based on merit through a competitive process that ensures the maximum impact and cost-effectiveness of R&D spending.

3. *Basic Research:* New federal energy R&D should focus on basic research. Private companies do not have incentives to embark on basic research that may not lead to the development of a new product. Additional government funding can compensate for this shortfall and provide basic research that is crucial to developing technologies in high-risk areas that the energy industry is unlikely to pursue on its own. Further, a focus on basic research would keep the government out of the business of choosing winners and losers.

   Some broad areas for potential funding include carbon sequestration, which requires additional development to make it cost effective and useable on a large scale. Another potential area of research is ocean fertilization, which would involve depositing nutrients into the ocean to stimulate the growth of CO2-absorbing phytoplankton. More research also needs to be done on the environmental impact and effectiveness of ocean fertilization and on reforestation.

4. *New R&D Funding Mechanisms*: An area that merits consideration is the use of new funding mechanisms for R&D. One potentially promising area would be the use of advanced market commitments, where a substantial prize would be offered to innovators who develop emission reducing technologies. For example, the government could offer a monetary award to the first firm that successfully captures half of an average power plant's emissions over 10 years and stores it successfully.

5. *Demonstrate Commercialization Potential:* The ultimate objective of federal energy R&D is to develop new technologies that are used in the marketplace. Thus, it is important that an energy R&D program include funding for demonstration – to show that new technologies can be implemented at a commercial scale. At the same time, funding for demonstration should not be expanded to include deployment of new technologies once their viability has been demonstrated, as this would crowd out the private sector.

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V. CONCLUSIONS

Substantially increasing the government's focus on R&D, and specifically energy R&D, will meaningfully impact two significant long-run problems facing the United States today. Both our dependence on fossil fuels and economic competitiveness are issues that cannot be resolved through short term solutions, now or in the future. By increasing funding for energy R&D (and R&D in other areas), the United States can start planting the seeds of innovation that will grow into new technologies that we cannot imagine yet, but will potentially reshape our energy landscape and place the our nation as a leader in clean energy.

The key purpose of my testimony has been to describe why R&D is crucial for our future competitiveness and to tackle the problems associated with climate change. Without this investment now, we are saddling future generations to difficult economic and environmental challenges. How to achieve these goals is another step altogether, and one that demands serious deliberation.

As with any long-term policy shift, there are difficult political issues that need to be resolved before this policy could move forward. The source of enhanced R&D funding is a central issue in the current budget context although it is important that the present fiscal situation not blind us to R&D's benefits. Another issue is how the government should manage its energy R&D programs. As I discussed earlier, the track record of the NIH and NSF shows that federal R&D funds are most effective when proposals are funded through an independent, peer-reviewed process by experts with research expertise.

As I mentioned, The Hamilton Project will be developing a specific set of policy proposals that adhere to the principles outlined here and confront some of the implementation challenges. I would welcome the opportunity to return to the Joint Economic Committee and discuss them.

Thank you very much for the opportunity to testify before you today. I would be happy to answer any questions that you might have.

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Potential Impact of Moratorium on Future Gulf of Mexico Production

E.G. Ward, Associate Director
Offshore Technology Research Center
Texas A&M University
July 24, 2010

Summary
A robust drilling program must continue to maintain or increase domestic oil production to provide for America's continuing energy needs even as alternative energy sources are developed for the future.

The purpose of this brief report is to examine the potential impact of a 6-month drilling moratorium on future production in the Gulf of Mexico. The US Energy Information Agency (EIA) has portrayed the impact as a minor reduction in GoM production (reference 1). However, the moratorium has the potential to cause a much greater impact.

In the face of a 6-month moratorium and uncertainties as to when drilling can actually be resumed and under what conditions and regulations, drilling rigs will leave the GoM and work overseas for extended periods. Two rigs have already announced their departure. This study assumed that the 6-month moratorium results in all drilling rigs leave the GoM with 2 or 5 year contacts to work elsewhere. The impacts on GoM production is studied for these two cases in which no drilling of any production or exploration wells occur during this 2 and 5 year period.

The results are summarized in the table below. The production declines at 15%/year due to natural reservoir production processes. Additional oil is imported to replace this "lost" production and maintain the 2010 production rate, further increasing America's dependence on foreign oil. These additional imports add significantly to the tanker traffic in the GoM. The value of the imported oil ranges from $3 to $96 Billion.

Summary: Potential Impact on GoM Oil Production Assuming the 6-Month Drilling Moratorium Results in No Drilling in the GoM for a 2-Yr or 5-Yr Period after the Moratorium

Year	Years Before Drilling Resumes	Production Rate (MBOPD)	Volume of Lost Production (MMBO)	Additional Shuttle Tankers to Import Lost Production Volume	Value of Lost Production (at $70/bbl)
2010		1,600			
2012	2	1,069	450	1,500	$3,150,000,000
2015	5	657	1,375	4,500	$96,250,000,000

MBOPD = Thousand barrels of oil per day. MMBO = Million barrels of oil.

These unintended consequences of the moratorium are significant. Additionally, the moratorium has significant negative impacts on domestic businesses, employment, energy prices, energy and national security, and safety. Hopefully the extreme cases illustrated in this study will not come to pass. But the study does illustrate how quickly GoM production can deteriorate if a large number of drilling rigs leave the GoM as a result of the moratorium. And drilling rigs have already begun to leave.

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Potential Impact of Moratorium on Future Gulf of Mexico Production

E.G. Ward, Associate Director
Offshore Technology Research Center
Texas A&M University
July 24, 2010

Moratorium and Assumptions

The blanket moratorium was imposed on May 27, 2010. An injunction was filed, another moratorium was imposed on July 13, 2010, and other injunctions are expected. Notices to Lessees have been issued seeking to clarify shallow and deep water restrictions, and new safety requirements are being specified. It is recognized that the moratorium has been lifted for shallow water wells, but the new regulations in place are sufficiently restrictive such that few new permits have been approved.

The purpose here is to look at reductions in total GoM production due to the moratorium. While the drilling moratoriums that have been issued to date are for 6 months, the longer term impact of the moratorium will be estimated and account for two key factors –

1. In the face of a 6-month moratorium and uncertainties as to when drilling can actually be resumed and under what conditions and regulations, it is assumed that all deepwater rigs will leave the GoM and work overseas. Two contract periods will be considered – 2 years and 5 years before these rigs return to the GoM. As of this date, two rigs have already announced that they are leaving the GoM.

   Thus the *effective* length of the moratorium with regard to completing ongoing wells or drilling new wells will be assumed to be 2 and 5 years.

2. GoM production will decline during this period when no ongoing wells are completed or new wells are drilled, and additional imports will be required to replace the oil that would have been produced at the pre-moratorium production rate of 1.6 MMBOPD production

Production from deep water (> 1000 ft) and shallow water (<1000 ft) production is lumped together as total production. Shallow water represents about 30% of the total recent production, and future large oil fields will likely be in deep water. For simplicity here, the moratorium is assumed to ban all drilling in both deep and shallow waters.

Annual Average Oil Production Rates through 2010

Figure 1 shows the total (deep and shallow) average annual production rate in thousand barrels of oil per day (MBOPD) for the years 1993 – 2010.

Historical production data for 1993-2008 was taken from Minerals Management Service (MMS) data (reference 2).

Total production rate data for 2009 was taken from EIA data (reference 3).

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Total production rate for early 2010 was reported as 1.6 MMBOPD by the Wall Street Journal (reference 4).

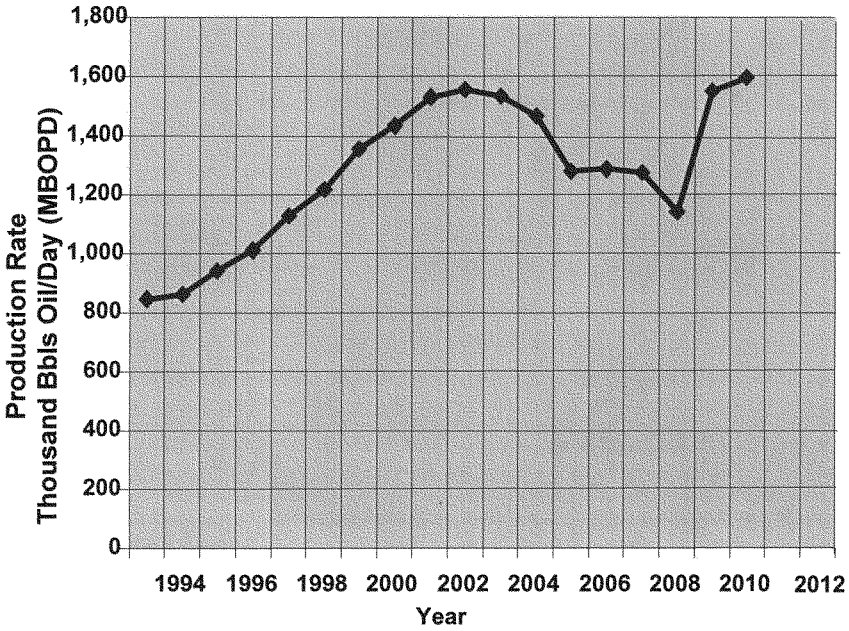

Figure 1. Historical Average Annual Total (Deep + Shallow Water) Production Rate for Federal Waters in the Gulf of Mexico

Note that the total production rate first peaked in 2002 and then declined due to a number of factors including

- the natural decline due to production
- operational interruptions and infrastructure damage due to hurricanes in 2004, 2005, and 2008

During this time, total production decreased about 4.4 %/yr.

In 2009 and early 2010, repairs were completed and production was restored and also expanded due to additional production from new projects, and oil production exceeded the 2002 peak.

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Production Decline Rates
The MMS uses production decline rates in their forecast of future production from existing or new fields (reference 1). Deep water oil production is assumed to have an "effective" decline rate of 12 %/yr. This decline rate is based on operators' data and historic data on deepwater reservoirs. Similarly, the effective decline rate for shallow water oil production is assumed to be 13 %/yr. It is presumed that these decline rates derived from individual reservoir performance include the beneficial effects of ongoing drilling for reservoir management and production maintenance. To allow for this, the effective rate of decline for a strictly no drilling case will be conservatively assumed to be 15%/yr. Others have reported higher rates of 20% or more (reference 5).

It was noted above that the peak production rate declined by 4.4%/yr between 2002 and 2008. This represents a "net" decline that included the "effective" decline from producing reservoirs as discussed above; interrupted production due to severe hurricanes in 2004, 2005, and 2008; and additional production from new projects that were starting up. This can be expressed as -

Net Decline = Effective Reservoir Decline + Production Interruption + New Production

It is not possible to estimate the relative size of each of these terms from readily available data. But it is worth noting that between 2002-2008, production was started from 21 new deep water structures and 58 new subsea projects (reference 1). For example, production rate increases totaling 250 MBOPD was reported in 2008 from new platforms (reference 5), yet the overall production rate decreased. With all these new project additions in 2002 – 2008, the production rate still had a net decline of 414 MBOPD (4.4 %/yr) from the 2002 production rate of 1,556 MBOPD.

Production Decline and Loss Production Due to Moratorium
To examine the possible impact of the moratorium as described above, i.e., no drilling for 2 or 5 years due to all rigs leaving the GoM with 2 or 5 year contracts to work overseas, the resulting production decline and the associated "lost" production are estimated using the 15%/yr decline rate discussed above. Results for 10%/yr and 20 %/yr are also shown as a measure of the sensitivity of production rates and the loss of production to production decline

Production Decline The production decline from 2010 to 2016 is shown in Figure 2 for the cases of no drilling for 2 years and for 5 years. Note that the points plotted represent the annual average for the year and are plotted mid-year. The cessation of all drilling is assumed to take place in mid-2010, and the average annual production rate is 1, 480 MBOPD for 2010. In 2012 after 2 years, the production rate falls to 1,069 MBOPD, a decrease of 411 MBOPD. Similarly, the production would drop to 657 MBOPD after 5 years, a decrease of 823 MBOPD.

The U.S. Energy Information Administration (EIA) (reference 1)recently stated *"The reductions in crude oil production resulting from the moratorium are estimated to average about 31,000 bbl/day in the forth quarter of 2010 and about 82,000 bbl/day in 2011".* Figure 2 includes these EIS estimates and shows that the EIA estimated impact is

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significantly less. In the present study, the production rate has decreased to 1,258 MBOPD, a decrease of 222 MBOPD as compared the EIA estimate of 82 MBOPD. It is expected that the EIA estimate presumed that drilling would immediately resume at the pre-moratorium capacity at the end of 6 months of the moratorium. This is a unrealistic scenario given that two rigs left the GoM for long-term contracts elsewhere during the first month after the moratorium was announced.

Production Loss The production "loss" refers to the production which will not occur in the GOM due to the production decline as measured against the 2010 production rate. The production loss could be described as simply *deferred*, but it is "lost" in the sense that it would have to be replaced by imports during the interim period to maintain the GoM production that existed prior to the moratorium. The production "loss" from 2010 to 2016 is shown in Figure 3 for the cases of no drilling for 2 years and for 5 years. The production loss is 269 MMBO (Million barrels of oil) after 2 years and 1,375 MMBO after 5 years. It is noted that 1,373 MMBO is 1.375 Billion barrels of oil – 1,375,000,000 bbls.

To replace these production volumes with imports would significantly increase tanker traffic in the GoM since the oil would have to be delivered to the existing infrastructure along the GoM coast for processing, refining, and delivery. Oil imports enter the GoM in large oil tankers which are too large to enter ports along the Gulf. Oil is transferred from these larger tankers to smaller shuttle tankers which take the oil to shore. Replacing the 2-year loss of oil with imports would require an additional 1,500 shuttle tanker trips. Replacing the 5-year loss of 1,375 MMBO would require an additional 4,500 shuttle tanker trips.

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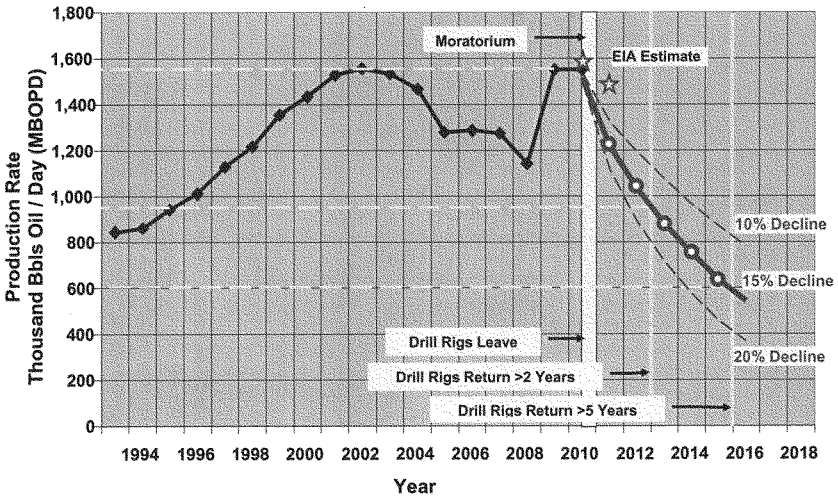

Figure 2. Production Rate Decline Resulting from No Drilling in the GoM for a 2-Yr or 5-Yr Period because all Drilling Rigs Left the GOM to Work Elsewhere during the 6-Month Moratorium

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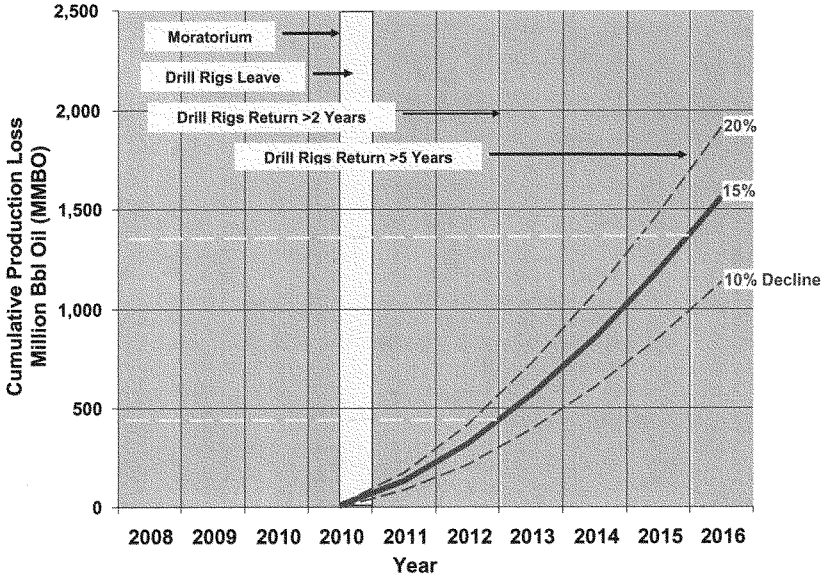

Figure 3. Cumulative Production Loss Resulting from No Drilling in the GoM for a 2-Yr or 5-Yr Period because all Drilling Rigs Left the GOM to Work Elsewhere during the 6-Month

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Production Rate Recovery after the Moratorium
After the moratorium and the absence of drilling for either 2 or 5 years, the recovery of production to the 2010 production rate would present a significant challenge. Large deep water GoM projects have production capacities of 200 MBOPD. Thus the 2 year drop in GoM production rate (1,600 to 1,069 or 531 MMBOPD) would require about 3 new large projects to restore the production rate back to 2010 levels. Full production from each project could be achieved in about 5 years (which would be ~ 7 years after the moratorium) for pre-existing discoveries. A large number of reservoir management and maintenance wells (e.g., workover, waterflood, sidetrack, water disposal wells) would also be required to offset declined and declining production in existing fields. The returning rig fleet would be in high demand and challenged to accomplish these tasks as well as explore for new fields. Increasing the production rate to above the 2010 level would be an even larger challenge.

If the majority of the rigs did not return to the GoM until after 5 years, the challenge to return to 2010 production levels would be even larger.

Conclusions
The possible resulting impacts are summarized in the table below. The production declines at 15%/year due to natural reservoir production processes. Additional oil is imported to replace this "lost" production and maintain the 2010 production rate, further increasing America's dependence on foreign oil. These additional imports add significantly to the tanker traffic in the GoM. The value of the imported oil is shown and ranges from $3 to $96 Billion.

Table 1 Summary: Potential Impact on GoM Oil Production Assuming the 6-Month Drilling Moratorium Results in No Drilling in the GoM for a 2-Yr or 5-Yr Period after the Moratorium

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2012	2	1,069	450	1,500	$3,150,000,000
2015	5	657	1,375	4,500	$96,250,000,000

These unintended consequences of the 6-month moratorium are significant. Additionally, the moratorium has significant negative impacts on domestic businesses, employment, energy prices, energy and national security, and safety.

Hopefully the extreme cases illustrated in this study will not come to pass. But the study does illustrate how quickly GoM production can deteriorate if a large number of drilling rigs leave the GoM as a result of the moratorium. Drilling rigs have already begun to leave.

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References

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2. **Gulf of Mexico Oil and Gas Production Forecast: 2009 – 2018, MMS Report 2009- 012,** U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, May 2009
3. **Short Term Energy Outlook Supplement: 2010 Outlook for Hurricane Related Production Outages in the Gulf of Mexico**, US Energy Information Administration, June 2010
4. **Wall Street Journal**, June 29, 2010.
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U.S. Senator Jim DeMint -- Questions for the Record
Joint Economic Committee
Tuesday, July 27, 2010
Michael Greenstone, Ph.D, 3M Professor of Environmental Economics, Massachusetts Institute of Technology

Question 1: Separating the merits of the technologies for a moment, a critical question policy makers should ask is whether the government should be making these investment choices in the first place. We can look to our own country for examples of poor investments. A case in point is Solyndra, a California solar panel manufacturer. The company was one of the early beneficiaries of loan guarantees under the stimulus bill, to the tune of $535 million. Vice President Joe Biden said that the investment was "exactly what the [stimulus bill] is all about." Solyndra, in spite of government largesse, was forced to cancel a $300 million initial public offering because of a critical audit by PricewaterhouseCoopers, which raised concerns about the firm's viability. The concerns are understandable given that Solyndra's production costs are six times those of other producers. Could you explain why future investments will turn out differently than Solyndra?

Question 2: Could you speak to the results of Spain's green jobs program? For every one green job created, an estimated 2.2 jobs were lost in the private sector. How will the government subsidization of clean energy jobs in the United States be different?

Question 3: Only two years ago, Spanish solar energy companies using generous government subsidies expanded at a rapid pace, investing €18 billion (then worth roughly $28 billion) to cover rooftops and fields with photovoltaic panels. They briefly turned the country into the top solar market in the world. The investment soon turned sour as the market crashed under a wave of subsidy cuts, fears of possible forced tariff paybacks, and allegations of fraud involving energy produced at night being sold as solar power to collect super-premium prices. What lessons can the United States draw from the Spanish experience? And what is or should be systemically different about the United States' approach to promoting clean energy?

Question 4: A recent Congressional Budget Economic and Budget Issue Brief, "How Policies to Reduce Greenhouse Gas Emissions Could Affect Employment," studies the negative impact of CO2-cutting policies like cap and trade or carbon taxes. The study found that, "In particular, job losses in the industries that shrink would lower employment more than job gains in other industries would increase employment, thereby raising the overall unemployment rate." Yes, subsidized green jobs are technically new jobs. But won't they destroy more jobs than they create?

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Question 5: In the case of wind energy could you speak to the economic costs of adding the necessary transmission lines to transfer power from where it is generated to where it is needed?

Question 6: Could you explain why nuclear energy should or should not be a part of our nation's energy portfolio?

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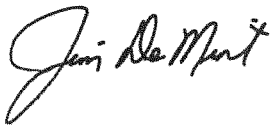

U.S. Senator Jim DeMint -- Questions for the Record
Joint Economic Committee
Tuesday, July 27, 2010
Anthony E. Malkin, President, Malkin Holdings

Question 1: The Heritage Foundation estimates that if mandated, a Renewable Energy Standard would raise electricity prices by 36 percent for households and 60 percent for industry. A Renewable Energy Standard would also reduce our nation's Gross Domestic Product by $5.2 trillion between 2012 and 2035 and reduce employment by more than 1 million jobs. Could you please explain the tradeoffs involved, and how the benefits of a Renewable Energy Standard might offset such losses or prove beneficial to Americans?

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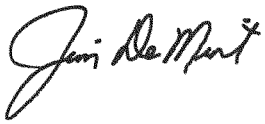

U.S. Senator Jim DeMint -- Questions for the Record
Joint Economic Committee
Tuesday, July 27, 2010
E.G. (Skip) Ward, Ph.D, Associate Director, Offshore Technology Research Center, Texas A&M University

Question 1: The Heritage Foundation estimates that an offshore drilling ban would reduce our nation's Gross Domestic Product by $5.5 trillion over the next 25 years. Such a ban would also reduce job growth by more than 1 million jobs by 2015 and more than 1.5 million jobs by 2030. Could you please explain the tradeoffs involved, and how the benefits of an offshore drilling ban might offset such losses or prove beneficial to Americans?

Question 2: Could you explain why nuclear energy should or should not be a part of our nation's energy portfolio?

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August 27, 2010

Michael Greenstone
3M Professor of Environmental Economics, MIT
Director, The Hamilton Project
Senior Fellow, The Brookings Institution

Responses to Follow Up Questions from Senator DeMint
July 27, 2010 JEC Hearing – "Promoting a Clean Energy Economy"

1) Thank you for your question regarding the Solyndra case. While I am not familiar with this particular case I can provide some general thinking about the benefits of general research and development that we would not create by investing in specific firms or technologies. In line with the general rules of the market, private firms have a strong incentive to focus on applied research that has a relatively high probability of leading to a marketable product rather than pursue basic research that may have general applications. Private firms play a very valuable role in our country's R&D, but it does have a very particular focus.

   Government can and should play an important role in support of basic or general research. Because private forms cannot capture all the benefits of the more basic research they are less likely to undertake it. However, basic research is a crucial ingredient in innovation and economic growth because it benefits firms across an industry or many industries, and can lead to game-changing breakthroughs that could reshape our energy future. I highlighted several examples of technologies of everyday importance for which government basic research funding has been critical in my testimony. Some examples include: the development of plant genetics, fiber optics, magnetic resonance imaging, computer-aided design and computer-aided manufacturing (CAD/CAM), data compression technologies that make all manner of electronic devices more powerful, progress toward edible vaccinations, and the "eye chip" that might help 6 million blind Americans see.

2) I have not studied Spain's green jobs program carefully so I cannot speak authoritatively about it. However, as I discussed in my testimony, one key to solving our nation's economic and energy problems can be found in beginning a new program of energy R&D that is narrowly focused on funding research that the private sector will not undertake on its own.

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As I argued in my testimony, the NSF and NIH offer good models for an expanded energy R&D program. In the NSF and NIH well-qualified scientists make decisions about research funding independent of political influence. It is not my role, as an economist, to pre-judge which projects should be funded. Rather, we should focus on structuring the research funding such that decisions about what projects to fund are left in the hands of experts.

3) I have not conducted a careful analysis of Spanish programs to stimulate production of electricity from solar sources so I cannot speak about this case. In general, governments should not subsidize particular technologies and instead more directly aim policy at the central problem which in this case is the release of greenhouse gases through the use of fossil fuels. Of course, there are exceptions to all rules and it is sensible to judge these policies on a case-by-case basis.

   I want to underscore that there I believe that there is a strong case for the United States Government increasing its support for basic energy research projects. A judicious program of these investments could produce advancements that affect whole industries rather than particular firms. The power of such a targeted program is that basic research is a key building block for innovation, yet private firms rarely pursue these research activities because they cannot capture all of the benefits. In these cases, there is a solid case for government support of this type of research.

4) This is certainly a complicated question. Yes, it is likely that a cap and trade or carbon would marginally decrease employment. But it is also likely that climate change itself will have significant costs to the economy and that over several decades, the cost of doing nothing about climate change would outweigh the costs of implementing a national cap-and-trade program.

   Let me explain this in more detail: A narrow focus on the employment impacts of a national cap-and-trade program fails to recognize the economic benefits resulting from a reduction in greenhouse gas emissions. The most recent estimate from the United States Government for the social cost of carbon, the cost of the release an extra ton of greenhouse gases into the atmosphere, is that an additional ton of carbon emitted now will cause $21 of damage worldwide.

   Using this estimate of the social cost of carbon, I recently analyzed the costs and benefits of different cap-and-trade programs that have been debated in the past year in Congress. I found that the global cumulative benefits of the emissions reductions in the American Power Act, the cap and trade bill considered by the Senate, were in the range of $1.5 to 1.7 trillion between now and 2050. In contrast, EPA estimated that the total domestic

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costs of the American Power Act would be $600 billion to $1 trillion over the same time period.

In summary let me suggest that there is not a simple answer to this question and I would be delighted to discuss my recent findings on the social cost of carbon more fully at your convenience.

5) I have not studied the economics of wind-generated electricity in the United States and cannot comment intelligently about the costs of adding transmission lines to connect new wind sources of energy to the grid.

6) The composition of our nation's energy portfolio will require a number of policy choices. There are a variety of factors that should be considered --- many of them sensitive to the diversity of America's regions and states, and to our national security. From a purely economic perspective, I believe a factor in this decision-making should be an evaluation of energy source's full costs. This includes the generation costs, any social costs (e.g., release of greenhouse gases and conventional pollutants), and impact on energy security. Nuclear power has many important advantages, including zero carbon emissions and domestic production that make it an important part of the energy portfolio. Whether its role should be expanded depends – at least in part -- on the costs of nuclear energy relative to other alternative sources of energy. In particular, I'm uncertain whether without federal subsidies nuclear energy is cost competitive once the costs of storing spent fuel, developing the infrastructure and reducing the risk of accidents are included. Again, this is a complex question and I hope that I have helped to address a part of the necessary thinking around nuclear energy.

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Malkin Holdings

MEMORANDUM

To: Alec Aramanda

From: AEMalkin

Date: August 11, 2010

Re: Questions for the Record
Joint Economic Committee
Tuesday, July 27, 2010
Question posed by US Senator Jim DeMint

I write in response to the following question submitted for my response:

> The Heritage Foundation Estimates that if mandated a Renewable Energy Standard would raise electricity prices by 36% for households and 60% for industry. A Renewable Energy Standard would also reduce our nation's Gross Domestic Product by $5.2 trillion between 2012 and 2035 and reduce employment by more than one million jobs. Could you please explain the tradeoffs involved, and how the benefits of a capital Renewable Energy Standard might offset such losses or prove beneficial to Americans?

The area in which I have professed expertise is not in Renewable Energy Standard setting, but in energy efficiency retrofits in the existing built environment. At the Empire State Building, in partnership with the Clinton Climate Initiative, Johnson Controls, Jones Lang LaSalle, and the Rocky Mountain Institute, we have created the first replicable, transparent, non-proprietary, open source, quantitative program for economically justified energy efficiency retrofits in the existing built environment.

I can attest that at the Empire State Building, we are creating jobs through the retrofit process that we are implementing, buying new equipment and upgrading existing equipment to meet our requirements, and reducing our watt and BTU consumption by over 40%. The payback period on our investment is three years.

By reducing our energy consumption, we are reducing the need to replace existing energy production with renewable energy sources. We are also allowing for reduction of production of energy from non-renewable energy sources. Our savings are permanent. We consume too much energy for the amount of work product we generate in the United States, and we consume too much energy as consumers. By reducing our energy consumption for business purposes, we will create new jobs and reduce our dependency on polluting and/ or imported fuels and enhance national security.

Onward and upward.

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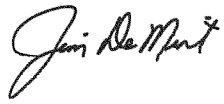

U.S. Senator Jim DeMint -- Questions for the Record
Joint Economic Committee
Tuesday, July 27, 2010
E.G. (Skip) Ward, Ph.D, Associate Director, Offshore Technology Research Center, Texas A&M University

Question 1: The Heritage Foundation estimates that an offshore drilling ban would reduce our nation's Gross Domestic Product by $5.5 trillion over the next 25 years. Such a ban would also reduce job growth by more than 1 million jobs by 2015 and more than 1.5 million jobs by 2030. Could you please explain the tradeoffs involved, and how the benefits of an offshore drilling ban might offset such losses or prove beneficial to Americans?

Question 2: Could you explain why nuclear energy should or should not be a part of our nation's energy portfolio?

Responses to Senator DeMint's Questions
E.G. (Skip) Ward, August 16, 2010

Question 1: I wish there was an opportunity for me to ask for clarification to better understand the question, but here is my response based on my present understanding. Also my expertise is more in technical areas of offshore oil and gas than in the macro-scale business and economic aspects of the offshore oil and gas industry. With these caveats , here is my response.

I expect that the reduced job growth refers to non-oil related unemployment, and would be the result the further deterioration of the US economy that would result from a reducing domestic oil supply. There would certainly be no job growth in the offshore oil and gas business. The majority of the existing expertise and talent would become unemployed by a drilling ban and would be create additional job losses. They would either join the unemployed ranks of the US, retire, or go elsewhere. Those employed in fields that provide indirect support and services would also become unemployed and add to the job losses. The job losses by those both directly and indirectly working in the offshore oil industry would add to the reduced job growth in other sectors and further worsen US unemployment.

Offshore production accounts for about 30% of the current domestic production. A ban on all offshore drilling would put the present production level in a permanent decline mode. The decline rate I used in my simple analyses of the production decline resulting from a 2 or 5 year hiatus was 15 %/year. Using this decline rate, in 5 years (2015) the GoM production rate would fall to 44% of its present 2010 value, which would be 15 % of the total domestic production, assuming the onshore production rate remained constant. In 10 years (2020), the GoM production rate would be down to 20% of the present value, and represent only 7 % of the total domestic production. In 15 years (2025), the GoM production rate would be down to 9% of the present value, and represent only 3 % of the total domestic production. At some point in the future, decline production and revenues along with increasing maintenance and operating costs due to a reduced offshore service industry would likely force all offshore platforms to be shut down prematurely.

Assuming the continuing need for oil remains constant over the next 15 years as the US is in the early phases of transitioning to alternative energy sources and that onshore production remains constant, the decrease in offshore production would have to be offset by increasing imports. Shuttle tanker traffic to GoM ports would increase by about 1100 trips/yr in 2015 to 1700 trips/yr in 2025, increasing the risks of near shore oil spills. There are currently about 1400 shuttle tanker trips/year, so the increase in imports would roughly double the amount of shuttle tanker traffic in

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the GoM.

The reduction in domestic production will decrease royalty and tax revenues to the federal and state governments. The increase in imports will worsen the US balance of payments. It is likely that the demand and cost of oil will increase due the recovering global economies and US shortages.

There have been ~50,000 wells drilled in the US OCS, with 4,000 in depths > 1,000 ft and 700 in depths > 5000 ft. The blowouts that resulted in spills > 1000 barrels of oil are as follows

Year	Operation	Oil Spilled (1000 bbl)
1964	Hurricane	10
1965	Drilling	2
1969	Collision	3
1969	Drilling	80
1970	Production (fire)	30
1970	Workover	53
1971 - 2009	All	18

Note the large improvement that occurred after 1970 due to the introduction of modern MMS standards. Blowouts are very rare events.

In summary, I believe that the great risks and harms that a total ban on offshore drilling wold have on the US (including economic losses, unemployment, increased dependence on foreign oil and the resulting national security issues, higher prices, loss of government revenues, increased likelihood of near shore spills) far outweigh the potential harm associated with the risks of future blowouts. Efforts should continue to further improve safety, but a total ban on drilling is not warranted.

Question 2: I believe that nuclear energy can and should be a larger part of the US's energy portfolio. In modern times, it has proved to be a clean and reliable source of energy in the US and elsewhere. For example, I believe that France gets more than 70% o the electrical power from nuclear energy. However, efforts to improve waste disposal should continue,

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August 27, 2010

Michael Greenstone
3M Professor of Environmental Economics, MIT
Director, The Hamilton Project
Senior Fellow, The Brookings Institution

Follow-up Information from Michael Greenstone
July 27, 2010 JEC Hearing - "Promoting a Clean Energy Economy"

1) What do you think of HR5505 - the Nuclear Fuel Prize Act of 2010?

The Nuclear Fuel Used Prize Act of 2010, which was introduced in the House of Representatives on June 10, 2010, implements a program to award competitive cash prizes for research, development, demonstration and commercial application of nuclear used fuel storage technologies. It authorizes the Department of Energy to enter into an agreement with a private nonprofit entity to administer the prize competition. Winners of the competition would be selected "based on the goal of safely and adequately storing nuclear used fuel." The bill would authorize $10 million each for two awards, $2 million for two additional awards to "support continued actions to develop the successful entities" between 2011 and 2022.

The safe storage of used nuclear fuel is one of the main obstacles to the expansion of nuclear energy and this prize could be effective in spurring private-sector innovation in that area. During my testimony before the JEC, I supported the use of innovative funding mechanisms such as the prizes advocated in this bill. An appealing feature of these prizes is that if applicants are unable to meet the criteria for the prize then it will not cost the United States Government any resources. In this sense, there is a guarantee that the money will be spent wisely.

One potential suggestion for changes to the bill would be specific and verifiable prize criteria—for example, the bill could offer a prize for the best safe storage system for nuclear waste that could be proven to last over a given period of time and have the lowest threshold of risk for damage to the environment. Additionally, I strongly support the bill's call for the administration of the prize to be done by an outside nonprofit entity that presumably is free of any associations with the applicants.

My view is that experimentation with prizes in the area of energy research is a worthwhile direction for federal policy. Of course, the success of such programs should be closely monitored.

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2) How do you know that the jobs created by any new innovative industry won't just be quickly shipped overseas? How can we be sure that the jobs will stay in America?

One concern that arose during the Clean Energy Innovation hearing is the question of where benefits from increased federal energy R&D will be located. Will new industries and jobs created by new research stay within the United States, or will they simply move overseas where labor is cheaper?

In short, we can't guarantee that new U.S. technologies and industries will stay within our borders. However, some relatively new research – some of which I've been a part of – shows that the originating country does benefits significantly from its new innovations.

Economic research indicates that the benefits, primarily the new ideas, from research and development activities are "sticky." Put another way, they tend to disproportionately benefit workers and firms located near the discovery location. In particular two consistent findings in the research support the idea that innovation will have substantial and long-lasting economic benefits to the region where the innovation originally occurs.

First, several studies suggest that innovation from one firm spills over to nearby firms. Put another way, areas or regions where an innovation is developed are more likely to have more innovations developed in similar industries or fields in the future. David Audretsch and Maryann Feldman (1996) found that innovative activities tend to cluster in areas where technology and science plays a large role, and that industries where knowledge spillovers are more relevant tend to have greater concentrations of R&D.[1] Adam Jaffe (1993) found that patent citations came disproportionately from the same state or metropolitan area as the originating patent. In other words, new innovation disproportionately occurred in the same location where the basis for that innovation was developed.[2] A 2006 study looking at the benefits from pharmaceutical research found that patents by pharmaceutical firms within a therapeutic class were positively correlated with a firm's exposure to papers related to that class authored within 35 miles of where the firm conducts research. Further, the same paper found that patent output was significantly correlated with publicly authored work in the firm's area.[3]

Second, research focused on broader spillovers suggests that there are positive spillovers from firms and residents to the region. Research that I co-authored with Richard Hornbeck and Enrico Moretti found that the opening of a large industrial generated significant increases in the

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[1] Audretsch, David, and Maryann Feldman. 1996. "R&D Spillovers and the Geography of Innovation and Production." *American Economic Review* 86 (June): 630-640.
[2] Jaffe, Adam B., Manuel Trajtenberg and Rebecca M. Henderson. 1993. "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citation." Quarterly Journal of Economics 108 (August): 577- 598.
[3] Furman, Jeffrey, Kyle, Margaret, Cockburn, Iain, Henderson, Rebecca M. 2006. "Public & Private Spillovers, Location and the Productivity of Pharmaceutical Research." Working Paper no 12509, NBER, Cambridge, MA.

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productivity of existing plants in the same area.[4] Another study found that plants' wages and productivity increased more in cities that experienced large increases in the share of college graduates than in cities which experienced smaller increases in the share of college graduates.[5] These results all suggest that geography matters, and that communities experiencing a concentrated development in a particular industry will see benefits in other related industries.

Of course, it is inevitable that some jobs created through the application of the ideas generated by federal R&D will migrate to other countries. However, these two results – that there are spillovers to innovation and that more broadly there are spillovers from both firms and residents to the rest of the community, suggest that federal support of basic R&D is likely to produce substantial long term benefits for the U.S. economy, especially for the regions where the innovation takes place.

3) How do private and public energy R&D expenditures compare? What proportion of R&D is undertaken by the public sector and what proportion by the private sector?

As I stressed in my testimony, private and public R&D are not good substitutes. Private R&D tends to be focused on applications that will primarily benefit the firm that makes these investments. In contrast, basic public R&D creates knowledge that can benefit many firms or even entire industries.

Figure 2 below illustrates that overall business gross domestic expenditure (including all industries, not only the energy industry) on R&D has been rising in real terms from its 1981 level of $61 billion to $218 billion in 2008. During that time period, government expenditure on R&D has increased from $59 billion to $88 billion. In other words, in the last 27 years government R&D spending has increased 49% while private sector R&D has increased 259%. However, Figure 2 shows that as a percentage of GDP, government R&D spending has declined from its 1980s peak of 1.29% of GDP in 1985 to only 0.76% of GDP in 2008. In contrast, private sector R&D funding has increased from 1.16% of GDP in 1981 to 1.9% of GDP in 2008.

However, the patterns for energy R&D spending differ significantly. Figure 3 below demonstrates that in the energy sector, private and public R&D growth has been weak since the 1970s. Private sector R&D spending has been falling in real terms since the 1990s. Further, the energy sector spends only 0.03% of sales on research and development, compared with 18.7% in the pharmaceutical sector, 11.5% in the aerospace and defense sector, 7.9% in the computers and electronics sector, and 2.4% in the computer and electronics sector.[6] It is also worth noting that

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[4] Greenstone, Michael, Hornbeck, Richard, Moretti, Enrico. 2010. "Identifying Agglomoration Spillovers: Evidence from Million Dollar Plants." MIT Department of Economics Working Paper.
[5] Moretti, Enrico. 2004. "Workers' Education, Spillovers and Productivity: Evidence from Plant-Level Production Functions." *American Economic Review.*
[6] American Energy Innovation Council. "A Business Plan For America's Energy Future." http://www.americanenergyinnovation.org/full-report

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much of private sector R&D goes toward commercialization or applied technologies, rather than basic research that can generate spillovers across industries.

Figure 1.

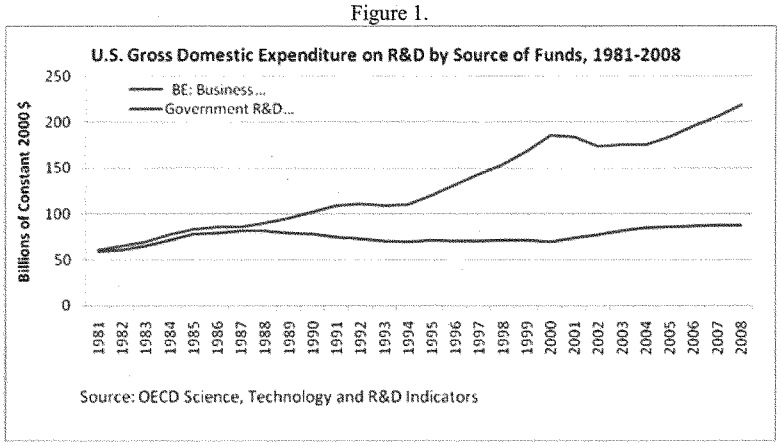

Figure 2.

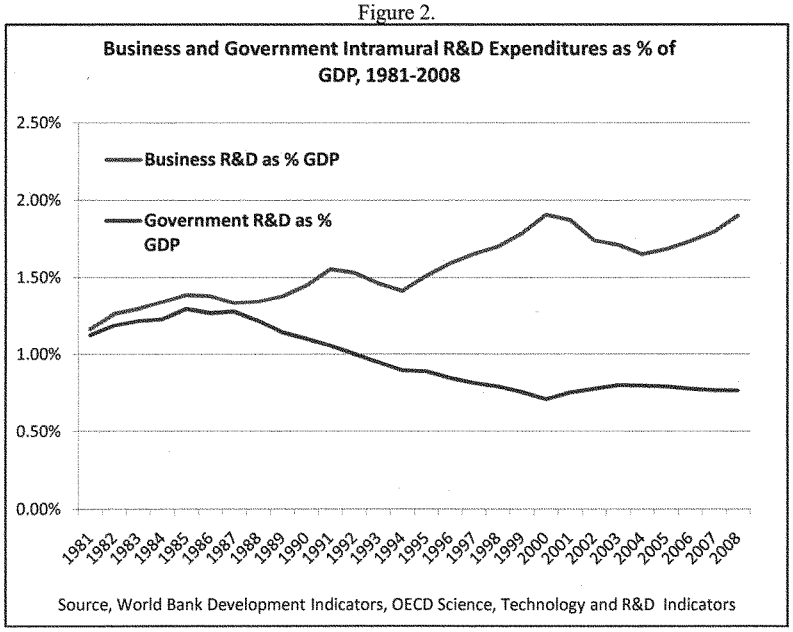

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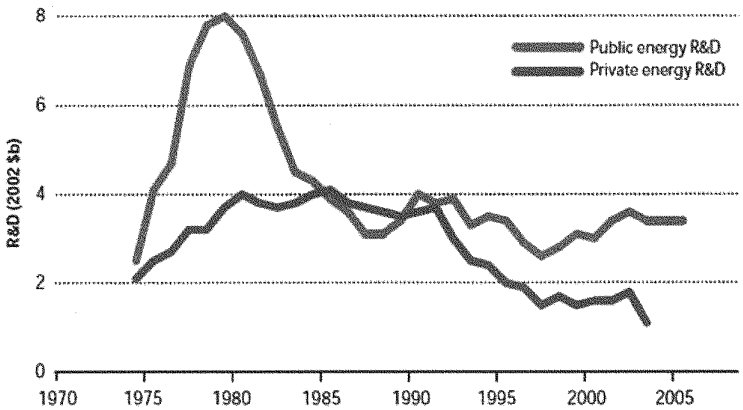
Figure 3.

Declining energy R&D investment by both public and private sectors



Sources: R. M. Wolfe, Resea rch and Development in Industry" (National Science Foundation, Division of Science Resources Statistics, 2004); M. Jefferson, *et al.*, "Energy Technologies for the 21st Century" (World Energy Council, 2001); R. L. Meeks, "Federal R&D Funding by Budget Function: Fiscal Years 2003-05" NSF 05-303 (National Science Foundation, Division of Science Resources Statistics, 20040; R. Margolis, and D. M. Kammen "Underinvestment: The energy technology and R&D policy challenge", *Science*, 285, 690-692 (1999).

Source for "Declining Energy R&D Investment by both public and private sectors" graph: Kammen, Daniel, Nemet, Gregory. "Reversing the Incredible Shrinking R&D Budget." *Issues in Science and Technology*. Fall 2005, p. 85. www.climatetechnology.gov/stratplan/comments/Kammen-2.pdf

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