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BLOWING IN THE WIND: RENEWABLE ENERGY AS THE ANSWER TO AN ECONOMY ADRIFT

HEARING

BEFORE THE

SELECT COMMITTEE ON
ENERGY INDEPENDENCE
AND GLOBAL WARMING
HOUSE OF REPRESENTATIVES

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BLOWING IN THE WIND: RENEWABLE ENERGY AS THE ANSWER TO AN ECONOMY ADRIFT

THURSDAY, MARCH 6, 2008

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ENERGY INDEPENDENCE
AND GLOBAL WARMING,
Washington, DC.

The committee met, pursuant to notice, at 9:43 a.m., in Room 2175, Rayburn House Office Building, Hon. Edward Markey (chairman of the committee) presiding.

Present: Representatives Markey, Blumenauer, Inslee, Larson, Solis, Herseth Sandlin, Cleaver, Hall, McNerney, Sensenbrenner, Shadegg, Walden, Sullivan, Blackburn and Miller.

Also Present: Representative Eliot Engel of New York.

The CHAIRMAN. This hearing of the Select Committee on Energy Independence and Global Warming is called to order. Yesterday, President Bush addressed the Washington International Renewable Energy Conference to once again say that the United States has to get off oil. But this administration's rhetoric does not match the reality that it is continuing to defend Big Oil at the expense of American consumers, our economy and the planet.

After nearly eight years of this administration's backwards energy policy, the oil companies now have us over a barrel. Today, after OPEC refused to answer President Bush's plea to open the spigots, oil prices broke yet another all-time record, rising above $105 per barrel, up from $30 a barrel when President Bush took office. And consumers are paying the price at the pump. Gas prices have now reached a nationwide average of $3.18, more than doubling since the President took office. The prospect of $4 gas may be news to the President, but it is not news to the American people, who are being tipped upside down every time they fill up.

Skyrocketing energy prices are also hurting the U.S. economy. The Department of Labor reported that the economy lost 17,000 jobs in January, the first monthly decline in four years.

But we have a new driver of economic growth and job creation waiting to be unleashed. We are on the cusp of a renewable energy revolution. Last year, we led the world by installing 5,244 megawatts of new wind power, roughly 30 percent of all new electricity generation installed in the United States. Solar photovoltaic installation also grew by more than 80 percent in 2007.

Transitioning to a green economy has the potential to create hundreds of thousands of green jobs, generating economic oppor-

tunity everywhere from the hearts of our cities to the heartland of our country. An analysis by the Clean Tech Venture Network estimated that as many as 500,000 new green jobs could be created by 2010. But the tax incentives that have driven this growth of renewable energy are poised to expire once again.

In recent years when these tax incentives have been allowed to lapse, the impact has been dramatic. For example, new wind installation dropped between 77 and 93 percent each of the three times that the production tax credit expired since 2000. If we do not provide certainty to investors by extending these tax incentives early this year, we are likely to see the recent growth of renewable energy grind to a halt.

Our economy and our planet cannot afford it. If the tax credits for solar and wind expire this year, it will lead to an estimated $19 billion in lost investments, and 116,000 lost job opportunities through 2009.

Last week, the House passed legislation that would repeal unnecessary tax breaks for the largest oil companies and use those funds to extend those vital tax incentives for wind, solar and other renewable technologies. But rather than join the overwhelming bipartisan majority supporting this bill that would begin to restore the long-term health of our economy and our planet, the Bush administration is continuing to stand with Big Oil in opposition.

In April of 2005, President Bush said, quote, "with 55 dollar a barrel oil, we don't need incentives for oil and gas companies to explore." Well, now, with that price nearly double, our economy on the brink of recession and our planet's thermometer rising, it is time for this administration to finally back up its rhetoric and support incentives for wind and other renewables that will reduce global warming pollution, not make it worse; create jobs rather than hurt consumers; and turn our economy green rather than push it deeper into the red.

And now I would like to turn and recognize the Ranking Member of the Select Committee, the gentleman from Wisconsin, Mr. Sensenbrenner.

[The prepared statement of Mr. Markey follows:]

Opening Statement for Chairman Edward J. Markey
"Blowing in the Wind: Renewable Energy as the Answer to an Economy Adrift."
Select Committee on Energy Independence and Global Warming
March 6, 2008

This hearing is called to order.

Yesterday, President Bush addressed the Washington International Renewable Energy Conference to once again say that the United States has to "get off oil." But this Administration's rhetoric does not match the reality that it is continuing to defend big oil at the expense of American consumers, our economy, and the planet.

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But the tax incentives that have driven this growth of renewable energy are poised to expire once again. In recent years, when these tax incentives have been allowed to lapse the impact has been dramatic. For example, new wind installation dropped between 77 and 93 percent each of the three times that the production tax credit expired since 2000.

If we do not provide certainty to investors by extending these tax incentives early this year, we are likely to see the recent growth of renewable energy grind to a halt. Our economy and our planet cannot afford it. If the tax credits for solar and wind expire this year, it will lead to an estimated $19 billion in lost investment and 116,000 lost job opportunities through 2009.
Last week, the House passed legislation that would repeal unnecessary tax breaks for the largest oil companies and use those funds to extend these vital tax incentives for wind, solar and other renewable technologies. But rather than join the overwhelming, bipartisan majority supporting this bill that would begin to restore the long-term health of our economy and our planet, the Bush Administration is continuing to stand with Big Oil in opposition.

In April of 2005, President Bush said "with $55 oil, we don't need incentives for oil and gas companies to explore." Well now, with that price nearly double, our economy on the brink of recession, and our planet's thermometer rising, it is time for this Administration to finally back up its rhetoric and support incentives for wind and other renewables that will reduce global warming pollution not make it worse, create jobs rather than hurt consumers, and turn our economy green rather than push it deeper into the red.

And now I would like to recognize the Ranking Member of the Select Committee, the gentleman from Wisconsin, Mr. Sensenbrenner.

Mr. SENSENBRENNER. Thank you very much, Mr. Chairman. As I've said many times, promoting and advancing technology must be a key part of any global warming or energy security policy, and I am pleased that the chairman has scheduled this hearing today on renewable energy technology. This week people came to Washington from all over the world to talk about renewable energy.

President Bush addressed the Washington International Renewable Energy Conference yesterday, not to mention the scores of other government and business leaders who were here to examine the future of worldwide renewable energy production. The reason that everybody's talking about renewable energy production is because its future role is a vital part of the world's economy.

Traditional fossil fuels are and will remain a key source of worldwide energy production, but just like a strong investment portfolio that includes a diverse group of stocks and bonds, future energy portfolios should include a diverse array of energy technologies, including fossil fuels, renewable energy and nuclear power. On that point I am happy that the chairman has also scheduled a hearing for next week on nuclear energy technology. Nuclear power is safe, clean and produces no greenhouse gases. It, too, must be part of a diverse energy portfolio.

But diversity is the key. When it comes to energy security or environment protection, different energy technologies work better in different places. Each has its benefits and each has its drawbacks. For example, wind energy is a promising source of clean, renewable power. But the wind doesn't blow consistently and some areas are better for wind power than others.

As Interior Secretary Dirk Kempthorne noted at the conference yesterday, wind farms can hurt bird populations, some of which are already under stress. The Audubon Society has noted that the average population of common birds has declined 70 percent since 1967. So placing wind farms in places that will harm bird operations, bird populations, does not advance the cause of renewable energy, Secretary Kempthorne said, and I agree.

In the right places, wind farms will be a great source of renewable energy, but the shoe doesn't fit every footprint. Likewise, solar power is a great resource but mostly in areas where large tracts of land are available for use and the sun shines consistently. These should be just two options in a diverse energy portfolio.

The Energy Information Administration recently reported to the Senate its projections for future energy production, and the use of renewables in the U.S. will nearly double by 2030. But even then, renewable energy won't produce as much electricity as nuclear power currently does. The nuclear power only accounts for about 20 percent of the nation's electricity production. That's why maintaining diverse energy resources is a top priority.

By focusing on energy technologies like renewables and nuclear, combined with energy efficiency, the U.S. can meet many of the principles I believe are vital for any global warming policy. These technologies can help produce verifiable environmental benefits, and development of these technologies can help create jobs and improve the economy, which everybody agrees is a good thing.

I thank the witnesses for coming to enlighten us about the status of these technologies. I look forward to hearing more about them and yield back the balance of my time.

The CHAIRMAN. The gentleman's time has expired. The chair recognizes the gentleman from Oregon, Mr. Blumenauer.

Mr. BLUMENAUER. Thank you, Mr. Chairman. In 319 days, the United States will begin a new era where we will, no matter who is elected president—Mr. McCain, Ms. Clinton, Mr. Obama—we will have a Federal Government that is no longer resisting working with the rest of the world on issues of climate change and global warming, and there's strong signals that we will be moving more aggressively into a carbon-constrained economy.

There are those that talk about the future. I think our witnesses here today will demonstrate that that era is here now, in terms of not just the promise of renewable energy but its practice. And I had a chance to review some of the testimony. I'm familiar with some of what's going on. I think this is an important statement about where we are.

It is interesting that the era is here. The Federal Government needs to catch up. The Federal Government can learn from some of our witnesses about how to be a more sophisticated customer for energy. The Federal Government, as the largest consumer of energy in the world, has an opportunity to change dramatically, not just our carbon footprint, but bring many of these things to scale. We need to have a broad policy framework like a renewable portfolio standard that would help accelerate this in a way that enhances the market.

Last but not least, we need to realign our massive array of tax subsidies. The production tax credit you've referenced will be extended this year. It's outrageous that it has taken this long, and it is not something that is done on a multiyear basis rather than guessing year to year. We clearly do not need to give as much of a subsidy to the large oil companies that have found a way to make a profit, but there are some industries and technologies that are here today where a little bit of federal assistance could make a big difference with a fraction of that money.

I look forward to the hearing and appreciate your arraying it in this way.

The CHAIRMAN. I thank the gentleman. The gentleman's time has expired. The chair recognizes the gentleman from Arizona, Mr. Shadegg.

Mr. SHADEGG. Mr. Chairman, thank you very much for holding this hearing. I would like to start by welcoming a very important witness here today, Ms. Barbara Lockwood, who is the manager of Renewable Energy at Arizona Public Service Company. Barbara is here to talk about a new project that I'm very proud of that Arizona Public Service Company has just announced. It is the construction of the largest solar power plant in the world in my home state of Arizona. Barbara, thank you for being here.

I can't pass up this opportunity to tout the advertising campaign that is making Arizonans aware of this project. They take a weatherman—he's not a real weatherman—put him on camera and say, you know, here's the forecast for the next three days. Sunny, hot. Sunny, sunny, sunny, hot. Next week it'll be sunny, hot, sunny,

sunny, hot. And in June, it will be sunny, hot, sunny. If you're getting married in August, however, it'll rain. He pauses and says, no, just kidding. It'll be sunny and hot.

The Arizona people are embracing that campaign, and I am very excited about this project. I want to compliment Arizona Public Service. Obviously, technology is a part of the path forward. Solar energy needs to be a part of the path forward. And Arizona is emblematic of this entire issue, because in Arizona we have tremendous growth. The state is the second fastest growing in the nation. The city in which I live and represent is one of the fastest growing in the nation, and I am thrilled that we are moving forward both with technology in every area, but also particularly with technology in renewables.

In that vein, I'd like to point out something that has become at least a little bit of a trademark of my own, Mr. Chairman. I know yours is brilliantly funny opening statements. You may recall that years ago we did a hearing on renewables in the Commerce Committee, and I brought in the hydrologic cycle. And I want to point out, I took it out of a third grade text or a fifth grade text.

We were discussing at that time the issue of renewable energy, and in that particular piece of legislation, hydro was not considered renewable energy. And so I brought—I went to one of my staffers whose wife taught grade school, and I said does she happen to have a copy of the hydrologic cycle in a textbook? And they said, sure. Let's see if we can find one. And they found this one. And of course it shows, you know, rain evaporating up out of the ocean, coming into the clouds, the clouds move over the land and then come back down.

I would argue that we need to focus on the fact that hydropower needs to be an important part of this entire discussion. It is one of the single most efficient forms of renewable energy. Ninety percent of the available energy from a hydro power plant can be converted into electricity. It is emissions free, Mr. Chairman, so it addresses the issue of a carbon footprint. And I would urge my colleagues here as they look at renewable energy to focus on that.

There are new possibilities of in-stream flow. In the old days when we thought about hydropower we thought about you have to build a dam and put a turbine in the dam and then let the water out of the dam, and there are environmental consequences. We've actually gotten better since then. We can now do in-stream flow.

I just want to conclude with one fact. Today in Arizona, Glen Canyon Dam is producing one-third less power than it is capable of because of environmental damage downstream. That is the equivalent of two coal or natural gas-powered plants and their carbon footprint. If we were more innovative, if we used technology to a greater degree, we could create a second downstream—downstream, a second dam, operate that solely for environmental purposes, operate Glen Canyon Dam for hydroelectricity purposes, and eliminate the need for those two coal-fired plants.

I thank you, Mr. Chairman. I regrettably have another hearing that I'll have to attend and will miss part of this hearing, but I commend you for holding it. And, again, I commend Arizona Public Service Ms. Lockwood for her testimony.

The CHAIRMAN. The gentleman's time has expired. The chair recognizes the gentlelady from California, Ms. Solis.

Ms. SOLIS. Thank you, Mr. Chairman, and thank the witnesses for being here this morning as well. I, too, have another conflicting hearing that I'll have to leave to attend to. But I just wanted to touch on the economic crisis that we're facing across the country, but particularly in areas like mine.

We just heard from the Department of Labor in their recent reports that we've lost about 17,000 jobs in January. In my district, in East Los Angeles and Southern California, unemployment has reached above 7.2 percent, and we still don't have an accurate figure for a lot of our youth that have also been unemployed.

We've seen high levels of poverty, homelessness, and the last thing that people want to talk about is going to the gasoline station and having to fill up and putting in more than $50 to fill up half a tank. The prices there are outrageous, above $3.60 per gallon.

A recent report that we know in the American Solar Energy Society estimated back in 2006 that renewable energy and the energy sector generated, however, 8.5 million jobs, nearly a trillion dollars in revenue to the United States. And jobs in these sectors, as we know, provide livable wages, above the minimum wage, and in many cases will not be outsourced. They will be jobs that can stay here on our shores.

In this time of economic turbulence, it's important that we support those sectors of our economy that are providing that incentive. And I'm proud that last week the House passed the Renewable Energy and Energy Conservation Tax Act. I heard personally from many of our medium and small-sized businesses in Los Angeles at a recent event I held at the East LA Skill Center where we're finding that individuals are getting involved in training segments of our society that would otherwise not have an opportunity to get involved in placement and development of solar panels.

And there were many people there as businesses that were pleading with me, "Congresswoman, when is the Federal Government going to provide relief so we can provide the kinds of funds, the capital investment so that we can prolong these kinds of jobs?" My answer to them is I will do whatever I can as a part of—a Member of Congress here and that serves on this committee, but also ask them to also talk to our President and to the other side of the aisle. Because indeed, this is something that affects all of us.

I look forward to hearing from you. I know that we have a lot to do. Green collar jobs is an area that I've been working on. The President did sign a bill that would allow for $125 billion to be spent to create at least at a minimum 3 million jobs. Again, those jobs are very important to us. Help us. Let's step up to the plate. And I look forward to hearing from each and every one of you. Thank you.

The CHAIRMAN. The gentlelady's time has expired. The chair recognizes the gentleman from Missouri, Mr. Cleaver.

Mr. CLEAVER. Thank you, Mr. Chairman, and thank you for the hearing. I would like to express appreciation to our august panel today. Let me apologize in advance. I'm going to be running in and out. I'm on the Financial Services Committee, which is right

around the corner, and it starts at ten, so I'll be shuttling in between.

But I appreciate your presence here and I appreciate the fact that we are dealing with this energy, renewable energies issue, and the need to create green jobs. As the Federal Government becomes more and more sensitive, and I think Mr. Blumenauer is absolutely right—it doesn't matter who the president is. We're going to move deeper necessarily into the world that is becoming green-conscious. And we are going to need to create green jobs.

The committee I'm on, which also deals with housing and oversight for the Department of Housing and Urban Development, we are now requiring that all new HUD housing contain or be built with architects—by architects who create green houses. And I think you're going to see more and more legislation containing components that will require the greening of however we are spending our federal dollars. And so if we're going to do that, it seems to me that we need to create people who can handle those jobs, people who can put in solar panels.

I live in a city, one of the largest cities geographically in the country, 322 square miles with more circumferential highways than any other city per capita in the United States. We have one E–85 service station in that large area. And I'm told I drive an E–85 car that we are going to have a shortage of mechanics, for example, who can work on hybrids and E–85 vehicles. And so we are going to move into this new era, and unless we make preparations now, we're not going to have the workers who are going to be able to do the jobs to sustain the era we're trying to create.

And so, hopefully, you will be able to help provide us with some direction today that we might be able to use as we further sensitize Congress and the nation on the necessary changes that we've got to make as a nation.

I yield back the balance of my time.

[The prepared statement of Mr. Cleaver follows:]

U.S. Representative Emanuel Cleaver, II
5th District, Missouri
Statement for the Record
House Select Committee on Energy Independence and Global Warming Hearing
"Blowing in the Wind: Renewable Energy as the Answer to an Economy Adrift"
Thursday, March 6, 2008

Chairman Markey, Ranking Member Sensenbrenner, other Members of the Select Committee, good morning. I would like to welcome our distinguished panel of witnesses to the hearing today.

As economic and land development continues to change our country and our planet, more energy is necessary in order to accommodate this increased demand. To no one's surprise, consumption of electricity in our country increased over two percent annually from 1980 to 2005. Instead of seeing this need for more energy as a concern, this Committee and Congress should look at this statistic as an opportunity. This necessity must be seen as a chance to invest more heavily in renewable and clean energy, like wind and solar power.

The real concern is the delay both in industry and in government to commit to real action on this matter. The United States is the economic and technological center of the world, and yet we continue to fall behind other nations in renewable energy investment. We already know as a Committee, that so-called "green jobs" can help to save a sagging economy in a city, as well as investing in something that is domestic and secure. I know that a metropolitan area like my hometown of Kansas City, Missouri would benefit greatly from an industry commitment to renewable energy job creation. Congress should continue to encourage the investment of renewable, domestic energy for the sake of our economy, for our national energy security, and for the health of our planet.

I thank the panel for their insight and their suggestions concerning renewable energy investment and the economy, and I appreciate them taking the time to visit with our committee today.

Thank you.

The CHAIRMAN. Great. The gentleman's time has expired, and all time for opening statements by members of the Select Committee has expired, but we see that we have a guest here, Eliot Engel, a congressman from New York, and would the gentleman like to be recognized?

Mr. ENGEL. Yes. Thank you. Thank you very much, Mr. Chairman. I'll be very brief. And thank you for letting me participate. And this is obviously very important. I look forward to hearing all the witnesses this morning, especially my friend Bianca Jagger, chair of the World Future Council. Bianca has fought for many years for human rights as a human rights activist, and in many ways, we're talking about human rights. Because if we do what we're supposed to do with renewable energy, it's certainly a win for everybody.

I was looking at the notes that were passed out, Mr. Chairman, and one of the things that caught my eye is renewable energy tends to have higher construction and maintenance cost and lower or zero fuel cost, while fossil energy has the reverse cost structure. As a result, renewable energy technologies lead to a higher number of jobs per unit of energy generated compared to conventional fossil fuels. The construction, manufacturing, installation, operation and maintenance jobs produced by a megawatt of photovoltaic solar, for example, is 7 to 11 times greater than the number of jobs generated by an equivalent amount of coal or gas-generated electricity. So we're talking about clean air. We're talking about helping with global warming, and we're talking about creating new jobs and driving economic growth. It's certainly in my opinion the direction that our country should go in. We ignore global warming obviously at our own peril, and I believe that tax incentives for renewable energy is certainly the way to go. And I'm glad, as Ms. Solis said, that last week we passed a bill giving tax incentives, Renewable Energy and the Energy Tax Act. I really believe only government can drive this, and that's why this hearing this morning is so important.

So I thank you for letting me participate, and I am eagerly awaiting the testimony of our witnesses. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, and we welcome you, sir, to this hearing. And that completes the opening statements.

We'll now turn to our very distinguished witnesses, and our first one is Mr. Vic Abate, who is the Vice President for Renewable Energy from General Electric. This has been an incredible growth story. We're looking forward to hearing more about it. You have five minutes, Mr. Abate, whenever you are ready.

STATEMENT OF VIC ABATE, VICE PRESIDENT, RENEWABLE ENERGY, GENERAL ELECTRIC

Mr. ABATE. Thank you, Mr. Chairman and members of the committee. I appreciate this opportunity to testify on renewable energy, the economy, its potential to stimulate investment and job creation, and the critical importance of government policy in realizing this potential.

GE Energy is a power generation technology leader with more than 100 years of industry experience. Our global team consists of

36,000 employees. We operate in over 700 sites and in more than 100 countries. Our power generation business is a diverse portfolio consisting of thermal, gasification, nuclear and renewable energy technologies such as wind, solar and biomass.

With energy demand increasing dramatically and growing worldwide pressure to address greenhouse gas emissions, GE believes firmly that renewable energy must become an integral part of the 21st century energy mix. Supportive government policy has enabled the U.S. to become the global leader in new wind power installations. Last year the U.S. added over 5,000 megawatts, over 25 percent of the world's total wind power, and that's up from 55 megawatts a decade ago, so tremendous growth.

The U.S. installed over 45 percent—the installed base grew over 45 percent and now totals 16.8 gigawatts in 34 states and accounts for over 1 percent of the nation's electricity supply and powers over 4.5 million homes from this resource. Wind power accounted for 30 percent of all nameplate generation capacity added in the United States last year, second only to natural gas, and the U.S. is on pace to surpass Germany and become the nation with the largest installed base of wind power by the end of 2009.

The growth in wind energy is creating real economic energy security and environment benefits. According to the American Wind Energy Association, last year the industry spurred $9 billion in investment and created more than 50,000 new jobs. Much of this job growth has occurred in areas that have been hardest hit by manufacturing job losses. The installed base for wind power also displaces 3 percent of the natural gas consumption and avoids the emissions of 28 million tons of carbon dioxide from traditional power plants, the equivalent of taking 6 million cars off the road.

Policy-driven growth of the wind industry in the U.S. has helped GE expand its wind business revenues from less than $1 billion in 2004 to more than $6 billion this year. Over 8,000 of GE's 1.5 megawatt wind turbines have been installed worldwide, a number expected to exceed 10,000 by the end of this year.

Since entering the wind industry in 2002, GE has invested over $700 million in technology, increasing its wind turbine production six-fold and tripled its U.S. wind turbine assembly sites. We've expanded capacity from about 10 wind turbines per week to making 13 a day, and we've grown renewable energy jobs at GE to more than 2,700.

GE has also tripled the number of its suppliers, who now account for in excess of 2,000 U.S. jobs and cover 15 states. We see significant future job creation potential from wind energy and estimate that sustaining the growth rate we've seen over the past five years for the next five would triple the size of the industry and of the associated jobs.

To realize the potential for wind power we must meet three challenges: Technology, supply chain and policy. The cost of wind electricity has dropped 80 percent over the past 20 years, and GE's technology investments in efficiency, reliability and grid integration will continue to improve the competitiveness of wind power. GE is also driving supplier quality in wind industry through its Lean Manufacturing and Six Sigma processes.

The most critical challenge facing the U.S. wind industry is policy uncertainty. Long-term stable, predictable incentives reward innovation and enable technology manufactures and suppliers to invest and expand capacity to keep up with the growing demand. The current growth of the U.S. wind market is underpinned by the repeated extensions in 2005 and 2006 of the federal production tax credit that's set to expire at the end of 2008. Expiration of the tax credit would have a devastating impact on the domestic wind industry. Prior expirations at the end of 1999, 2001 and 2003 reduced wind power installations in the following year by 73 to 93 percent. A report estimates that failure to extend the credit this year would cause a 90 percent drop in wind installations, resulting in $11.5 billion lost investment and 76,000 job opportunities in 17 states in 2009 alone. Jobs that might have been created in the United States could shift instead to overseas areas like Europe and China, which are strengthening their wind policies.

In summary, GE believes that the United States is well positioned to benefit from the growth of the renewable energy industry. However, continued growth of this industry is dependent on stable, predictable policy. We urge the U.S. Congress to act immediately and extend the exiting production tax credit for wind energy.

Thank you for this opportunity to present this testimony, and I look forward to your questions.

[The prepared statement of Mr. Vic Abate follows:]

House Select Committee on
Energy Independence and Global Warming

Hearing on "The Renewable Energy Economy: A New Path to Investment, Jobs, and Growth"

Thursday, March 6, 2008

Written Testimony of
Victor Abate
Vice President, Renewables
GE Energy

Mr. Chairman and members of the Committee, I am Victor Abate, Vice President of Renewables at GE Energy. I appreciate the opportunity to testify on the renewable energy economy, its potential to stimulate investment and job creation, and the critical importance of government policy in realizing this potential.

GE Energy is a power generation technology leader with more than 100 years of industry experience. Our global team of 36,000 employees operates in over 700 sites in more than 100 countries. Our power generation business is a diverse portfolio consisting of thermal, gasification, nuclear, and renewable energy technologies such as wind, solar, and biomass.

With energy demand increasing dramatically and growing worldwide pressure to address greenhouse gas emissions, GE believes that renewable energy must become an integral part of the 21st-century energy mix. GE Energy contributes the largest number of products to GE's ecomagination initiative, a company-wide environmental commitment that includes an increase in "green" technology R&D from $700M in 2004 to $1.5B by 2010. This testimony will focus on wind, currently the most commercially viable renewable energy technology.

Renewable Energy Industry Growth

The United States, with its abundant domestic renewable energy resources, is well positioned to take advantage of this growing

industry. A supportive policy environment has enabled the US to become the global leader in new wind power installations. Last year the US added 5,244 MW—over 25% of the world total. The US installed base of wind power grew 45% and totals 16.8 GW in 34 states, accounting for over 1% of the nation's electricity supply and powering over 4.5 million homes. Wind power accounted for 30% of all nameplate generation capacity added in the United States last year, second only to natural gas. The US is on pace to surpass Germany and become the nation with the largest installed base of wind power by the end of 2009.

The growth of wind energy is creating real economic, energy security, and environmental benefits, according to studies by the American Wind Energy Association. Last year the industry spurred $9B in investment and created more than 50,000 jobs. Much of this job growth has occurred in areas hardest hit by manufacturing job losses. The installed base of wind power also displaces 3% of natural gas consumption and avoids the emissions of 28 million tons of carbon dioxide from traditional power plants—equal to taking 6 million cars off the road.

The solar industry is also expanding rapidly. According to the Solar Energy Industries Association, the US grew by 125%, adding 314 MW of solar power in 2007, stimulating some $2B in investment and creating over 6,000 new jobs—not only in sunny states of California and Arizona but also in the less sun-endowed states of Massachusetts and Michigan.

GE and Renewable Energy

The policy-driven growth of wind in the US has helped GE expand its wind business revenues from less than $1B in 2004 to more than $6B this year. Over 8,000 of GE's 1.5-megawatt wind turbines have been installed worldwide, a number expected to reach 10,000 by the end of this year.

Since entering the wind industry in 2002, GE has invested over $700M in technology, increased its wind turbine production 6-fold, and tripled its US wind turbine assembly sites. Renewable jobs at

GE have grown to more than 2,500. These include manufacturing jobs in Pensacola, FL; Greenville, SC; Salem, VA; Erie, PA and Tehachapi, CA as well as non-manufacturing professional jobs at our headquarters in Schenectady, NY. Last October we announced plans to add 500 more jobs in Schenectady in Wind Engineering, Project Management, and Services.

GE has also tripled the number of its suppliers, who now account for 2,000 US jobs and cover 15 states. These suppliers provide wind components and subcomponents such as blades, towers, bedplates, nacelles, gearboxes, generators, pitch and yaw bearings, hub castings, and cables.

GE's presence in the US wind segment gives us insight into its future growth, and we see significant job creation potential over the next five years. We estimate that sustaining a 30% growth rate over the next five years would triple the size of the U.S. wind industry and associated jobs.

Technological Advances and Challenges

To realize the potential of wind power, we must meet the three challenges of technology, supply chain, and policy. Technological advances have been central to the growth of wind. Innovations in turbine design have lowered wind's cost of electricity by more than 80% since 1985, primarily through increases in power output and rotor size to optimize energy capture. In 1985, the average US wind turbine was 100 kW with a 17-meter rotor diameter. When GE entered the wind industry in 2002, we inherited a 1.5-megawatt turbine with a 70.5-meter rotor.

Since 2002, we have made major technology and supply chain investments to further improve turbine efficiency by increasing the rotor diameter of our 1.5-megawatt turbine to 77 and 82 meters. This has increased capacity factor, or turbine efficiency, by 9 points. As a point of reference, a one-point increase in capacity factor over the US wind installed base could produce enough electricity to support 150,000 average US households.

GE has also invested to improve the reliability of our turbines. In 2002, availability of then state-of-the-art wind turbines was less than 85 percent. Technology advances in remote monitoring and diagnostics and the utilization of GE reliability modeling have increased the reliability of our wind turbines by 12 points of reliability. A one percent increase in availability over the US wind installed base could produce enough electricity to support 50,000 average US households.

GE is focusing on a variety of technology challenges to continue improving the competitiveness of wind. Examples include blade designs incorporating lightweight materials such as carbon fiber; grid integration technologies that enable wind projects to behave like a conventional power plant; and software to optimize the siting of our turbines to maximize energy capture.

GE has also focused on technology advances in solar energy since entering the industry in 2004. Cell efficiency improvements, molded wafer design, and thin-film technology are among the innovations currently being pursued. GE is also heading an alliance under the Department of Energy's "Solar America" program to further drive down the cost of solar electricity.

Manufacturing Challenges

Meeting growing demand for renewable energy presents enormous challenges and opportunities for manufacturers. The American Wind Energy Association and Department of Energy have identified a long-term target of 20% wind power by 2030. Yet even a 10% penetration by this date would require a five-fold increase from 2006 annual capacity of key components such as turbines, blades, and towers.

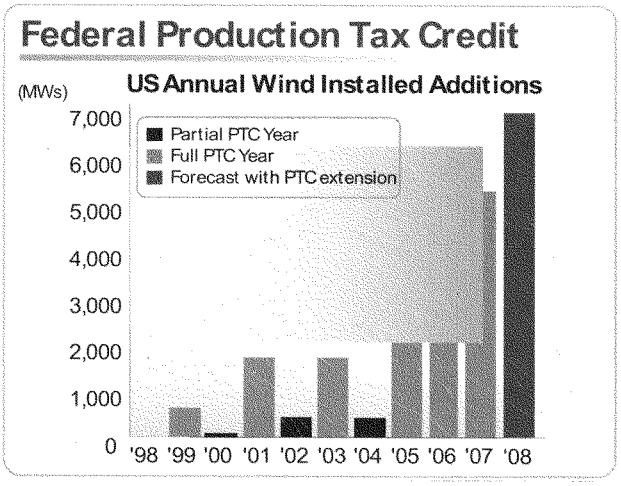
The challenge for industry will be to expand capacity while mitigating the supply chain bottlenecks that have previously impacted the industry. At GE, we are driving quality fulfillment by applying our Lean Manufacturing and Six Sigma expertise, a fully integrated master production schedule, and a rigorous process of auditing and certifying our suppliers. Last November, we celebrated with our suppliers the opening of two new blade supplier

manufacturing facilities for our 1.5-megawatt turbine in North Dakota and Iowa, which will create approximately 1,250 jobs.

Policy Challenges

The most critical challenge facing the US wind industry is policy uncertainty. Long-term, stable, predictable incentives encourage innovation and give technology manufacturers and suppliers the confidence to invest in expanding capacity to meet demand. Unpredictable policy, conversely, stunts technology investment and demand forecasting, limiting innovation and contributing to supply chain constraints.

A clear illustration of the importance of stable, long-term, predictable policy is the historical "boom-bust" pattern of the US wind segment resulting from the "on-again, off-again" nature of the production tax credit. When the production tax credit expired at the end of 1999, 2001, and 2003, wind power installations declined by 73-93%. By contrast, the repeated extensions in 2005 and 2006 have stabilized the policy environment, establishing the United States as the world leader in annual wind power installations and stimulating investment and jobs.



Source: American Wind Energy Association 2007.

Expiration of the tax credit would have a devastating impact on the US domestic wind industry. A recent report estimates failure to extend the wind production tax credit would cause a 90% drop in wind power installations, resulting in $11.5 billion of lost investment and a lost employment opportunity of 76,000 jobs in 17 states in 2009 alone.[1]

Wind Employment Impacts	
State	Lost Employment Opportunity Without PTC
Texas	23,139
Colorado	10,625
Illinois	8,938
Oregon	7,297
Minnesota	6,304
Washington	4,744
Iowa	5,254
North Dakota	2,343
Oklahoma	2,468
Pennsylvania	1,617
California	809
Missouri	976
New York	696
South Dakota	978
Maine	472
Hawaii	196
Massachusetts	24

Source: Navigant Consulting.

At a time when the United States is seeking to stimulate its economy, investment and jobs that might have been created in the United States could instead shift overseas to Europe and China, which are strengthening their wind policies. The European Union is developing a Binding Directive of 20% renewable energy by 2020. China, the third-largest wind segment in 2007, has established an aggressive national renewable energy standard that, if met, could

[1] Navigant Consulting, *Economic Impacts of the Tax Credit Expiration*, Final Report, Prepared for the American Wind Energy Association (AWEA) and the Solar Energy Research and Education Foundation (SEREF), February 13, 2008.

surpass the United States in wind power by the middle of the next decade.

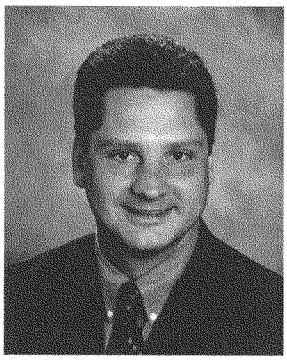
Failure to extend the renewable tax incentives would also cause the US to forgo long-term export opportunities. The connection between a stable domestic policy and a vibrant export sector for renewables is exemplified by Germany, whose incentive system has created the world's leading installed base in a country with a moderate wind resource. Wind power technology is the country's second-leading export industry after automobiles—a fact that US policymakers might consider as they explore options for increased job growth in depressed manufacturing regions.

While this testimony focuses on renewable tax incentives, it is important to draw attention to other forms of national and state policies that can sustain the growth of this industry. More than half (29) of the United States now have a Renewable Portfolio Standard, which requires utilities to devote an increasing percentage of their retail sales to renewable energy. These state policies have been the "fuel" to complement the wind PTC "spark": RPS states accounted for 95% of the wind power installed in 2007. GE has shared its views with several state governments that are considering the adoption of an RPS. In addition, a number of states and regions are beginning to develop climate change programs, some incorporating cap-and-trade policies.

Conclusion

In summary, GE believes that the United States is well positioned to benefit from the growth of the renewable energy industry. However, continued growth of this industry is dependent on a stable, predictable policy environment. We urge the US Congress to act immediately to extend the existing production tax credit for wind energy. While the focus of this testimony has been the wind energy industry, we also strongly support the extension of investment tax credits for solar energy, which are also set to expire at the end of 2008.

Thank you for the opportunity to present this testimony. I look forward to your questions.



Victor R. Abate
Vice President, Renewables
GE Energy
Schenectady, NY

Victor Abate is vice president of GE Energy's Renewables business, a leading global provider of wind and solar energy products and support services. He assumed this position in November 2005, and he is based Schenectady, New York.

GE Energy is one of the world's leading suppliers of renewable energy technology. With manufacturing and assembly facilities in Germany, Spain, China, Canada and the United States, the company's current renewable product portfolio includes wind turbines with rated capacities ranging from 1.5 to 3.6 megawatts, and solar electric power systems for on and off grid applications. The company's renewable installed base also exceeds 10 GW.

Prior to his current role, Mr. Abate was vice president of technology for GE Energy's power-generation segment, which includes gas, steam, wind, solar and hydro-turbine generators, gasification technologies and integrated gasification combined cycle.

Mr. Abate began his GE career in 1990 and has held several management roles in engineering, services, production and quality. In 1996, he led the large turbine generator business as the quality leader and was soon appointed general manager of generator technology. In 1999, Mr. Abate assumed responsibility in leading the gas turbine volume ramp in GE's power generation segment and in late 2000, he was appointed general manager of steam turbine technology. Mr. Abate became an officer of GE in 2003.

Prior to joining GE, Mr. Abate worked for Allied Signal and Zurn Industries and was responsible for mechanical drive technology and new product development.

Originally from Williamstown, Massachusetts, Mr. Abate holds bachelor's and master's degrees in mechanical engineering from Rensselaer Polytechnic Institute and Union College respectively, he also holds an M.B.A. from Rensselaer Polytechnic Institute.

The CHAIRMAN. Thank you, Mr. Abate, very much.

Our second witness is the Senior Director for Solar Markets and Public Policy for Applied Materials, Mr. Blair Swezey. Whenever you're ready, sir, please begin.

STATEMENT OF BLAIR SWEZEY, SENIOR DIRECTOR, SOLAR MARKETS AND PUBLIC POLICY, APPLIED MATERIALS

Mr. SWEZEY. Thank you, Mr. Chairman, and members of the committee.

The CHAIRMAN. Could you turn on your microphone, please?

Mr. SWEZEY. Oh, I'm sorry. Thank you, Mr. Chairman, and members of the committee, for providing us with the opportunity to testify today. We are very pleased to present our corporate perspective on the potential of the solar industry to create domestic jobs while at the same time providing an important solution to some of our most pressing energy and environment needs.

Applied Materials is a Fortune 500 company headquartered in Silicon Valley that employs approximately 14,500 workers worldwide, including nearly 8,000 here in the United States, with additional production facilities—I'm sorry. Our primary manufacturing facilities are in Austin, Texas, with additional facilities in Germany and Israel. We sell more than 80 percent of our products outside the United States, making us an important positive contributor to the U.S. balance of trade.

We recently celebrated our 40th year as a company and have a proud heritage of providing productivity-enhancing nanomanufacturing tools and equipment to the semiconductor and flat-panel display industries. We have now extended this technology and manufacturing expertise to providing the tools for production of solar electric photovoltaic or PV modules.

We see considerable growth potential in the rapidly expanding solar market. Our technology and production scale helped reduce the cost of transistors by a factor of 20 million between 1974 and today. Similarly, the price of flat panel displays has dropped by a factor of 20 in the past decade.

We fully expect to have the same impact on driving cost reductions for PV panel production by a factor of two to three, which will put solar electricity prices on par with grid power prices for large areas of the world. The key is getting to large-scale manufacturing by creating large markets.

The sheer magnitude of our energy supply challenges—meeting continued global demand growth while assuring economic prosperity, domestic energy security, and environmental quality—dictates that we accelerate the development of all available energy resource options. The question is not one of renewable resource availability, but of the economics of deploying the technologies to exploit these resources and how rapidly industry can ramp up the manufacturing capacity to produce the technologies.

First to economics. Electricity generation from photovoltaics is currently anywhere from two to three times more expensive than electricity generation from conventional sources. Nevertheless, global PV production has been growing at a rapid clip, rising at a rate of more than 40 percent per year over the past decade. This

growth is a direct result of governmental policies that have been established here in the United States and around the globe.

In the U.S., the Energy Policy Act of 2005 established a 30 percent investment tax credit, or ITC, for residential solar installations and raised the existing business energy ITC from 10 percent to 30 percent. A reduction in the credit would absolutely send the wrong signal to the investment community that is so critical in providing the capital for solar industry expansion. And so we commend the House of Representatives for its recent action in passing H.R. 5351, which includes extension of these tax credits and other important changes.

The other key element is domestic jobs and economic development. The solar industry creates manufacturing jobs with labor that is readily transferrable from other manufacturing industries. The United States is already a base for solar panel manufacturers and dozens of new startup operations. Applied Materials itself now employs about 900 employees in its Energy and Environmental Solutions group, which is just two-and-a-half years old.

While overall U.S. manufacturing job numbers continue to decline, renewable energy industries offer a whole new generation of manufacturing job potential. However, the fact that companies develop the technology here in the United States does not guarantee that they will also locate the production here in the United States. Achieving the job creation potential of the solar industry depends on continuing policy support to build the market.

The Solar Energy Industries Association, of which Applied Materials is a member, estimates that extending the current set of federal solar tax credits will create 55,000 new jobs in the solar industry and more than $45 billion in economic investment. Conversely, a recent study by Navigant Consulting estimated that failure to extend the credits will cost the country nearly 40,000 jobs and more than $8 billion of investment just through 2009.

Industry will locate where production conditions are most favorable, and manufacturers are also likely to invest and locate close to where viable end markets exist. However, companies need to see a clear market growth pathway to commit the substantial resources needed to ramp production capacity and output.

Unfortunately, in the case of PV manufacturing, many U.S. companies are increasingly looking abroad to expand their production, in part because of the uncertainty over future policy support. Speaking from our own corporate experience, 100 percent of our solar factory orders have come from outside the United States. So while our domestic business is advancing, the opportunity for a much larger U.S. industry platform is idle.

In summary, the PV industry is currently transitioning from one of component assembly operations to large scale manufacturing, which will dramatically increase the scale and throughput of PV module production in coming years. Solar photovoltaics is following a well documented pattern of cost decline, and with new technology approaches, is poised to create an accelerated cost reduction path. With our abundance of solar and other renewable energy resources, we are presented with the opportunity to manufacture our way toward domestic energy security and sustainability.

As a nation, we need to seize this opportunity. Applied Materials will do its part to make America competitive in this important and growing industry, and we stand ready to work with policymakers to develop a sound policy framework that will enable us and other innovative U.S. companies to lead the way.

This concludes my prepared remarks, and I look forward to your questions. Thank you again for the opportunity to speak before you today.

[The prepared statement of Mr. Blair Swezey follows:]

Testimony
of

Blair G. Swezey
on behalf of

Applied Materials, Inc.

Before the

Select Committee
on Energy Independence and Global Warming

U.S. House of Representatives

March 6, 2008
Washington, D.C.

Thank you, Mr. Chairman and members of the Committee, for providing us with the opportunity to testify today. I am Blair Swezey, senior director for solar markets and public policy at Applied Materials, Inc.

We are very pleased to present our corporate perspective on the potential of the solar industry to create domestic jobs while at the same time providing an important solution to some of our most pressing energy and environmental needs.

Applied Materials is a Fortune 500 company that ended our last fiscal year with nearly $10 billion in revenues. Headquartered in Silicon Valley, we employ approximately 14,500 workers worldwide, including nearly 8,000 here in the United States. Our primary manufacturing facilities are in Austin, Texas, with additional production facilities in

Germany and Israel. We sell more than 80 percent of our products outside the United States, making us an important positive contributor to the U.S. balance of trade.

We recently celebrated our 40th year as a company and have a proud heritage of providing productivity-enhancing nanomanufacturing tools and equipment to the semiconductor and flat-panel display industries. We have now extended this technology and manufacturing expertise to providing the tools for production of solar electric photovoltaic (or PV) modules.

We see considerable growth potential in the rapidly expanding solar market. Our technology and production scale helped reduced the cost of transistors by a factor of 20 million between 1974 and today. Similarly, the price of flat panel displays has dropped by a factor of 20 in the past decade due to scale and control of nanometer thin layers over areas the size of 60 square feet, making these technologies now ubiquitous in the marketplace.

We fully expect to have the same impact on driving cost reductions for PV panel production by a factor of two to three, which will put solar electricity prices on par with grid power prices for large areas of the world (see Figures 1 and 2). The key is getting to large-scale manufacturing by creating large markets.

The sheer magnitude of our energy supply challenges – meeting continued global demand growth while assuring economic prosperity, domestic energy security, and environmental

quality – dictates that we accelerate the development of all available energy resource options. Renewable energy resources are available in quantities that are more than adequate to meet total global energy demand many times over (see Figure 3). For example, the earth receives more energy from the sun in just one *hour* than the world uses in an entire *year*.

So the question is not one of resource availability, but of the economics of deploying the technologies to exploit these resources and how rapidly industry can ramp up the manufacturing capacity to produce the technologies.

First to economics. Electricity generation from photovoltaics is currently anywhere from two to three times more expensive than electricity generation from conventional sources in most sunny locations, depending on the application and the cost of capital. Nevertheless, global PV production has been growing at a rapid clip, rising at a rate of more than 40 percent per year over the past decade. This growth is a direct result of government policies that have been established here in the United States and around the globe to accelerate the use of renewable energy technologies in response to the ever-increasing demand for electricity, job creation, energy self-reliance and attention to the environment.

In the United States, the Energy Policy Act of 2005 (EPAct 2005) established a two-year 30-percent investment tax credit (ITC) for residential solar installations, subject to a $2,000 cap, and raised the existing business energy ITC from 10 percent to 30 percent.

The expiration date for both credits was later extended by one year in the Tax Relief and Health Care Act of 2006.

However, the business credit is scheduled to revert back to 10 percent and the residential credit to expire altogether at the end of this year, which will halt the growth in the domestic market just as the industry is beginning to attract the capital it needs to expand production and make solar energy more economic. A reduction in the credit would absolutely send the wrong signal to the investment community that is so critical in providing the capital for industry expansion.

For this reason, we favor a long-term extension of the 30-percent ITC for both businesses and homeowners. And we feel strongly that Congress should remove the utility property exclusion from the ITC because utility-scale applications offer a critical economic pathway to achieve the economies of scale that facilitate cost reduction. We believe that the development and application of utility "smart grid" technologies will play a key role in integrating large amounts of solar and other renewable energy sources. Utility-scale applications of PV would also help address critical electric grid reliability issues and defer the need for new electric transmission requirements.

We also support removing the $2,000 cap on the residential credit, or at a minimum significantly raising the dollar threshold. Furthermore, both the commercial and residential credits should be creditable against Alternative Minimum Tax (AMT) liability.

We commend the House of Representatives for its recent action in passing H.R. 5351, which includes most of these important extensions and changes.

The other key element is domestic jobs and economic development. The solar industry creates manufacturing jobs with labor readily transferable from other manufacturing industries. Similarly, renewable energy power plant development will draw from the same skilled engineering and construction labor pool as traditional power plant development. And smaller-scale solar projects can utilize much of the same labor pool as the residential and commercial construction industries. The solar industry will also generate many "standard" jobs for accountants, sales, engineers, computer analysts, factory workers, truck drivers, mechanics, etc.

The United States is already a base for solar panel manufacturers and dozens of new start-up operations. Applied Materials itself now employs about 900 employees in its Energy and Environmental Solutions group, which is just two and a half years old. There are also significant raw materials suppliers based in the United States providing feedstock materials such as silicon, glass and encapsulation polymers. And the installer networks are providing thousands of "green collar" jobs.

So while overall U.S. manufacturing job numbers continue to decline, renewable energy industries offer a whole new generation of manufacturing jobs with almost limitless potential. Solar energy is an important component of this job growth, since the solar

industry creates more jobs per unit of energy generated than any other energy source, renewable or fossil.[1]

However, the fact that companies develop the technology here in the United States does not guarantee that they will also locate production in the United States. Businesses are likely to invest and locate where a viable market exists. We only need to look at the recent experience of the wind industry, where new industries and manufacturing jobs have developed across the United States for the production of wind systems components, such as turbine blades, electronic controls, and towers.

The wind industry has seen great success but is several years ahead of the solar industry in market development. Realizing the job creation potential of the solar industry depends on continuing policy support to build the market. The Solar Energy Industries Association (SEIA), of which Applied Materials is a member, estimates that extending the current set of federal solar tax credits will create 55,000 new jobs in the solar industry and more than $45 billion in economic investment.[2] Conversely, a recent study by Navigant Consulting estimated that failure to extend the credits will ***cost*** the country nearly 40,000 jobs and more than $8 billion dollars of investment through 2009.[3]

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[1] Daniel Kammen, et al, "Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?" University of California, Berkeley, January 2004. http://rael.berkeley.edu/files/2004/Kammen-Renewable-Jobs-2004.pdf

[2] Testimony of Rhone Resch, President, Solar Energy Industries Association, Before the U.S. House of Representatives Committee on Ways and Means, Select Revenue Measures Committee, April 19, 2007.

[3] Navigant Consulting, Inc., "Economic Impacts of the Tax Credit Expiration," Prepared for the American Wind Energy Association and the Solar Energy Research and Education Foundation, February 13, 2008. http://www.seia.org/Navigant_Tax_Credit_Impact.pdf

Industry will locate where production conditions are most favorable. Manufacturers are also likely to invest and locate close to where viable end markets exist. Applied's thin-film solar manufacturing technology allows production of solar modules 5.7 m^2 in size, or roughly the size of a garage door, so end-market location will be an important determinant of manufacturing location. Put simply, if the United States develops a robust solar market, manufacturing and installation jobs will follow. However, companies need to see a clear market growth pathway to commit the substantial resources needed to ramp production capacity and output.

Although the United States accounts for nearly one-quarter of the world's electricity production, it deploys only about one-tenth of global PV production. This is because other countries are leading in policy support. For example, Germany accounted for nearly half of all PV capacity deployment in 2007 – even though the quality of the solar resource in Germany is about the same as that of Alaska – because of generous incentive structures designed to jumpstart the industry (see Figure 4). And at least 64 countries have a national target for renewable energy supply, including China and all 27 European Union countries.[4] We possess some of the most favorable solar resources in the world and we should be exploiting these resources to the fullest.

Unfortunately, in the case of PV manufacturing, many U.S. companies are increasingly looking abroad to expand their production, in part because of the uncertainty over future policy support. Speaking from our own corporate experience, 100 percent of our solar

[4] Renewable Energy Policy Network for the 21st Century (REN21), *Renewables 2007 Global Status Report*, February 2008.
http://www.ren21.net/globalstatusreport/default.asp

factory orders have come from outside the United States. So, while our domestic business is advancing, the opportunity for a much larger U.S. industry platform is idle.

In summary, the PV industry is currently transitioning from one of component assembly operations to large-scale manufacturing, which will dramatically increase the scale and throughput of PV module production in the coming years. Solar photovoltaics is following a well-documented pattern of cost decline but with new technology approaches, such as the use of thin-film semiconductor materials, is poised to create an accelerated cost reduction path (see Figure 5). The roadmap to achieving these cost reductions borrows from the tool set and production experience of the semiconductor industries.

New market entrants are bringing the necessary capital, technology and manufacturing experience from established and successful industries. Similarly, large established companies are investing in the capacity to provide specialized materials to supply this new industry. Cost reductions will come rapidly if the market grows to support the production scale required. The biggest risks to the industry are the availability and continuity of government policies to support the necessary market scale.

With our abundance of solar and other renewable energy resources, we are presented with the opportunity to manufacture our way toward domestic energy security and sustainability. As a nation, we need to seize this opportunity.

Applied Materials will do its part to make America competitive in this important and growing industry, and we stand ready to work with policymakers to develop a sound policy framework that will enable us and other innovative U.S. companies to lead the way.

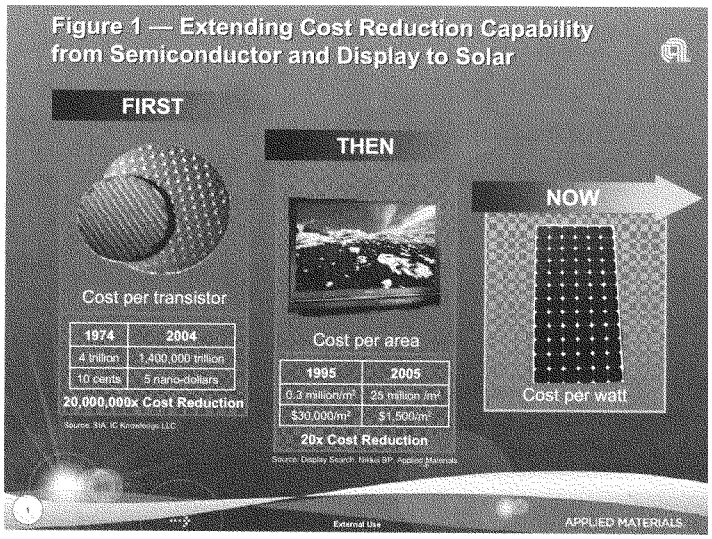
Figure 1 — Extending Cost Reduction Capability from Semiconductor and Display to Solar
FIRST
Cost per transistor
1974 | 2004
4 trillion | 1,400,000 trillion
10 cents | 5 nano-dollars
20,000,000x Cost Reduction
Source: SIA, IC Knowledge LLC
THEN
Cost per area
1995 | 2005
0.3 million/m² | 25 million /m²
$30,000/m² | $1,500/m²
20x Cost Reduction
Source: Display Search, Nikkei BP, Applied Materials
NOW
Cost per watt
External Use
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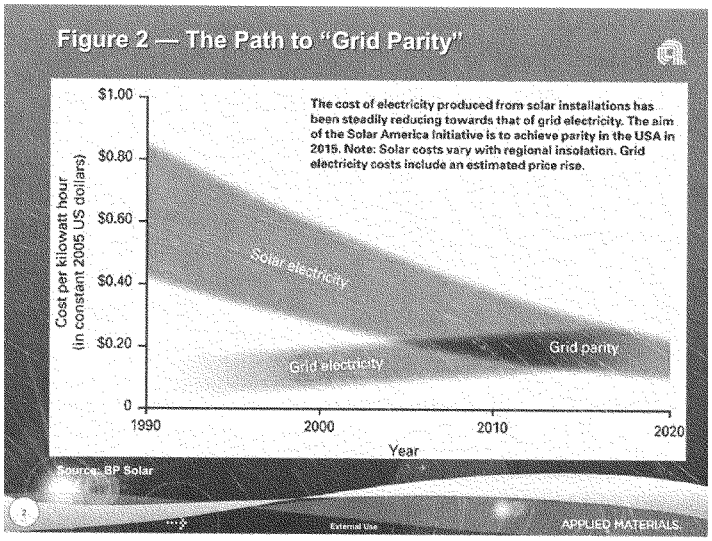
Figure 2 — The Path to "Grid Parity"
The cost of electricity produced from solar installations has been steadily reducing towards that of grid electricity. The aim of the Solar America Initiative is to achieve parity in the USA in 2015. Note: Solar costs vary with regional insolation. Grid electricity costs include an estimated price rise.
Cost per kilowatt hour (in constant 2005 US dollars)
$1.00
$0.80
$0.60
$0.40
$0.20
0
Solar electricity
Grid parity
Grid electricity
1990
2000
2010
2020
Year
Source: BP Solar
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APPLIED MATERIALS

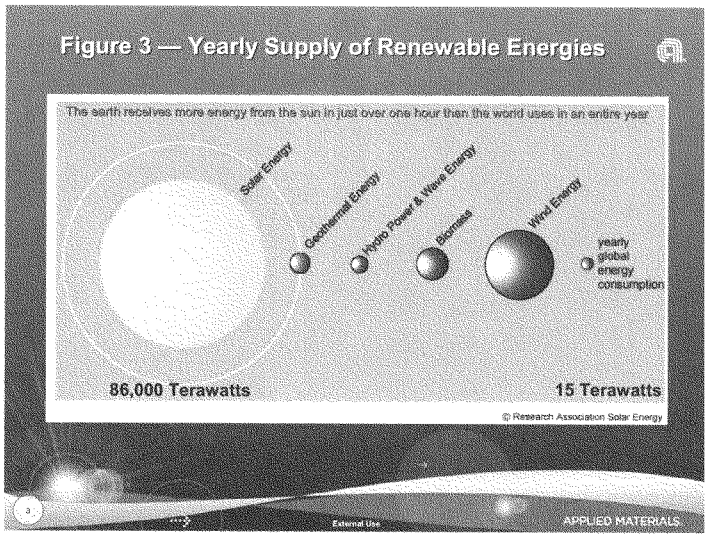
Figure 3 — Yearly Supply of Renewable Energies
The earth receives more energy from the sun in just over one hour than the world uses in an entire year
Solar Energy
Geothermal Energy
Hydro Power & Wave Energy
Biomass
Wind Energy
yearly global energy consumption
86,000 Terawatts
15 Terawatts
© Research Association Solar Energy
3
External Use
APPLIED MATERIALS

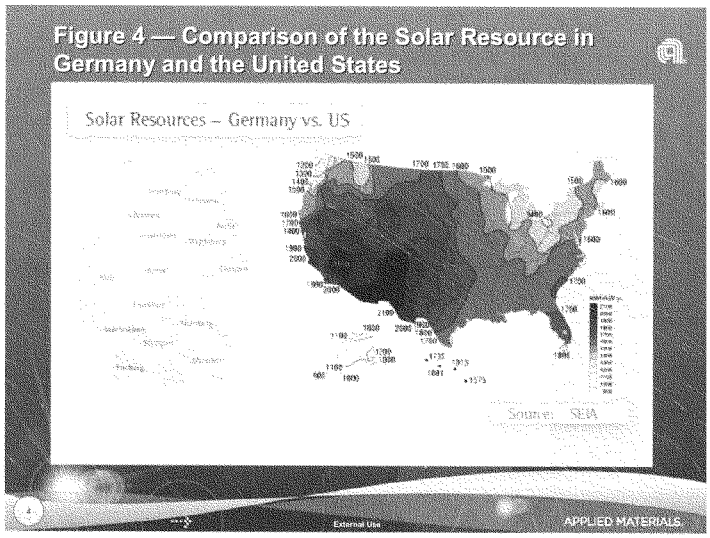
Figure 4 — Comparison of the Solar Resource in Germany and the United States
Solar Resources – Germany vs. US
Source: SEIA
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External Use
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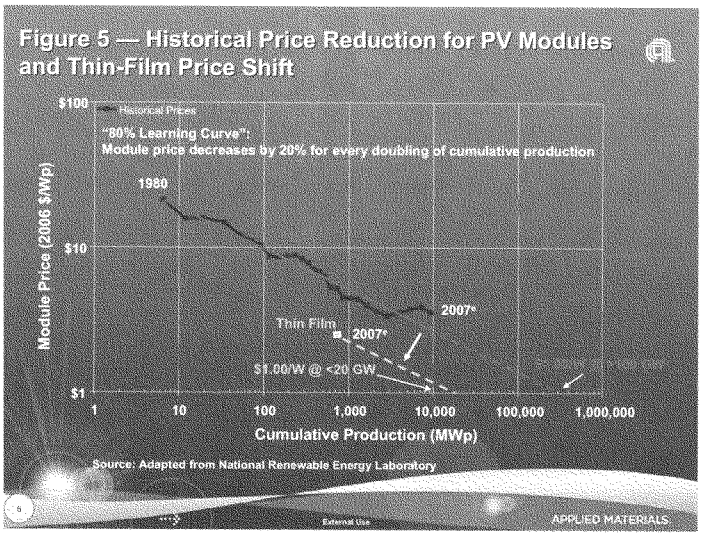


Figure 5 — Historical Price Reduction for PV Modules and Thin-Film Price Shift
Historical Prices
"80% Learning Curve":
Module price decreases by 20% for every doubling of cumulative production
1980
2007*
Thin Film
2007*
$1.00/W @ <20 GW
$100
$10
$1
Module Price (2006 $/Wp)
1
10
100
1,000
10,000
100,000
1,000,000
Cumulative Production (MWp)
Source: Adapted from National Renewable Energy Laboratory
6
External Use
APPLIED MATERIALS

The CHAIRMAN. Thank you Mr. Swezey.

Our next witness is Mr. Bill Unger from the Mayfield Fund, and he is here representing Environmental Entrepreneurs. We welcome you, sir.

STATEMENT OF BILL UNGER, PARTNER EMERITUS, MAYFIELD FUND, ENVIRONMENTAL ENTREPRENEURS (E2)

Mr. UNGER. Thank you. I'm a Partner Emeritus at Mayfield Fund. We're a venture partnership.

The CHAIRMAN. Could you move that microphone up a little bit closer, please.

Mr. UNGER. Okay. I'm part of a venture partnership that's invested in technology companies since 1970. I'm also a member of Environmental Entrepreneurs, which is an organization, a volunteer organization of 800 members across 25 states who believe that good environmental policy is good economic policy.

I'd like to thank the chairman and members of this committee and the House for their work in passing the Renewable Energy and Energy Conservation Tax Act. The extension of these incentives that provides an even playing field for all technologies is vital for our nation. We also hope that the Senate and the President will cooperate and pass this into law. It's a critical step to solving our urgent and intimately related problems of dependence on foreign energy, our economic growth and climate change.

For example, today, each ten gallon fill-up at the pump has been calculated as adding an additional $2.10 to as much as $11 per gallon when the full cost of the tax incentives, the $50 billion cost for protecting shipping lanes of oil, and health and environmental costs are fully loaded. And this is exclusive of the cost of the war. We add these dollars to our debt or pay in other ways to the tune of an additional $20 to $100 per tankful that is not evident at that particular point. Also, since the Energy Policy Act of 2005 was passed, which granted $6 billion of incentives to the oil industry, the oil industry has spent $112 billion repurchasing their shares on the open market. We would like to see a more even playing field.

I appreciate this opportunity to discuss with you the benefits of investment in clean tech jobs, economic growth and an improved environment. The need to address climate change is immediate. Because of the magnitude of this challenge, this new industrial revolution, properly addressed, could create more jobs, more economic prosperity, more personal investor, corporate and public servant satisfaction than has ever been seen for any number of the exciting technological innovations of the past.

The venture industry is proud of its role in job creation and bringing new technologies to market. In 2006, venture-backed companies provided 10.4 million U.S. jobs, and these companies had revenues of $2.3 trillion, and we are excited about Cleantech. The analysis it sounds like most of you are familiar with from UC Berkeley concludes, "the renewable energy sector generates more jobs whether it's measured on per megawatt of power installed per unit of energy produced, or per dollar of investment than the fossil-fuel-based energy sector." E2 estimates U.S. cleantech investment by 2010 will be $14 billion to $19 billion and will create an additional 400,000 to 600,000 jobs.

This is a big opportunity. How does it start? Often with the wealth of technologies generated at our own national laboratories and our universities. These are national resources. Really they're our treasures. DARPA and NIH play a crucial role nurturing technology development until the venture industry, which invests in product development, becomes interested. Our tax dollars paid for much of the pioneering work in solar and wind technology at our national labs. Much of the basic work for the hybrid engines on the road today was done at Stanford University, yet we are not the leaders in these fields. Germany, Denmark, Taiwan and Japan seized these opportunities and are prospering.

Since the energy crisis of the '70s, federal energy research spending is down significantly. And is this important? The market caps of Ford and General Motors are $13 billion each, and they're encouraging their employees to find other work. Toyota has a $176 billion market cap, and they have record employment. With an even playing field in terms of policy and federally funded R& D in a variety of technologies, we can regain market leadership. The semiconductor industry in the 1980s regained world leadership from exactly this kind of public-private partnership.

There's a high degree of technical knowledge spillover from the semiconductor and software industries to cleantech. Many of the entrepreneurs from these fields are now entering the cleantech industry. Their experience is an unmatched resource in the world. So this is a great story. Cleantech investors love it. In 2006, $2.9 billion was invested in cleantech, 76 percent increase over the previous year. Cleantech is now the third largest venture investment segment. The barriers that keep cleantech from growing fast enough to head off the climate crisis are inconsistent policy, long-term subsidies for conventional industries and trade barriers. These have to be corrected.

A mandatory, comprehensive national cap on greenhouse gas emissions, a national renewable energy standard and increased R&D funding are necessary. But these measures should not preempt states from going even further if they so choose. The Manhattan Project, the Marshall Plan, the space program, Roosevelt's rural electrification program and Eisenhower's interstate highway system are all examples of strong and visionary federal leadership. And unlike the Apollo program and the Manhattan Project, we can do this with existing technologies. We need to be the people the world have been waiting for. We need to be the people our children will say made the right decisions to give their children a safer, healthier and more prosperous place to live.

I look forward to your questions.

[The prepared statement of Mr. Bill Unger follows:]

ENVIRONMENTAL
ENTREPRENEURS

www.e2.org

Testimony of Bill Unger
Partner Emeritus at Mayfield Fund
Environmental Entrepreneurs (E2)

Select Committee on Energy Independence and Global Warming

Good morning Committee Chairman Markey, Ranking Member Sensenbrenner and Members of the Committee. I am Bill Unger, a Partner Emeritus at Mayfield Fund, a venture partnership investing in technology companies since 1970, and a member of Environmental Entrepreneurs (E2), a volunteer organization of business and investment professionals who believe that good environmental policy is good economic policy. I now spend only a part of my time investing in for profit companies, and more of my time as a board member of several non-profit organizations, such as CARE USA, YouthNoise, The Anita Borg Institute for Women and Technology, as an Advisor to and member of E2. I also serve on the advisory boards of the Colleges of Engineering at The University of California at Berkeley and The University of Illinois at Chicago. I appreciate the opportunity to be here today to share my views as a venture capitalist, and as a member of E2, on the creation of new jobs created in "Cleantech" related industries, including jobs created by measures taken in response to threat of Global Warming. In particular, I would like to show how the economic and employment growth of the Cleantech sector is related to a national carbon policy.

I appreciate this opportunity to discuss with you the benefits of investment in Cleantech; jobs, economic growth, and an improved environment. The energy-climate crisis is different in two ways from any other we face. First, although perhaps not yet as painfully visible as Iraq and other issues of the day, it will result in more profound implications for humanity than any other crisis in our civilized history. We will see these implications unfold increasingly rapidly over the next decade—unless we do something NOW. The second difference is that because of the magnitude of the challenge, this New Industrial Revolution, properly addressed could create more jobs, more economic prosperity, more personal, investor and corporate, and public servant satisfaction than has ever been seen before for any number of the exciting technological transitions that have occurred in the past.

I would like to thank the Chairman and members of this committee and members of the House of Representatives for their work in passing the Renewable Energy and Energy Conservation Tax Act of 2008. The extension of these incentives, providing an even playing field, is vital for our nation, and very supportive of the comments I will make today. Hopefully, the Senate will support this legislation, and the President will sign it into law. It is a critical step to solving our urgent and intimately related problems of dependence on foreign energy, economic growth and climate change.

As an example of the even playing field, the Energy PolicyAct of 2005 approved subsidies for conventional energy sources of $6B for oil and gas, $9B for coal and $12B for nuclear power, all mature industries. Conservation and alternative fuels were allocated $2.6B. Since 2005, oil companies have used over $112B of their profits to repurchase their shares in the public markets. Hardly an even playing field.

Some history of the Venture Capital industry's impact on our economy will set the stage. One of the achievements the venture capital industry is most proud of is our role in job creation. For example, the US semiconductor industry, as of the year 2000, employs 240,000 people in high-wage manufacturing jobs, and had sales totaling $102 billion in the global market in 2000 (50 percent of total worldwide sales). In 1999, this sector was the largest value-added industry in manufacturing in the U.S. - larger than the iron, steel and motor vehicle industries combined.

The 2005 employment data show a heavy concentration of venture capital supported jobs in the software industry as well, with nearly 860,000 jobs - almost 90 percent of the total jobs in the sector. Venture-backed companies recorded $210 billion in sales in 2005, which represents more than 36 percent of the industry's total revenues generated that year.

In 2006, venture backed companies provided 10.43 million US jobs and these companies had revenues of $2.3 Trillion. The revenue represents 17.6% of US GDP. Data from the National Venture Capital Association, (this entire study is at http://www.nvca.org/pdf/NVCA_VentureCapital07-2nd.pdf.) shows that at the end of 2006, one ongoing job existed in venture backed companies for every $28,463 invested in venture capital since 1970, or about 3,500 jobs for every $100M invested by the Venture Capital industry. (Investment in the 5 years preceding the jobs and revenue measurement date is not included because its effect on 2006 statistics would be minimal.) Furthermore in 2006, these companies generated $7.87 in revenue for every dollar invested. This is very impressive for an industry that typically invests less than 0.2% of GDP each year.

Looking just at the biotech world, for every dollar of venture capital invested, $4.43 in revenue was being produced in 2006 ($83 Billion total). As with VC in general, most of these investee companies failed. For every $76k of investment, one ongoing job existed in 2006 (and these are typically high-paying jobs). This refers only to the investment economic effect of biotech investment.

Publicly funded research, especially through such entities as DARPA and the NIH have played a crucial role in maturing technology development to the point where the Venture industry, which likes to invest in product development, can fund companies to bring

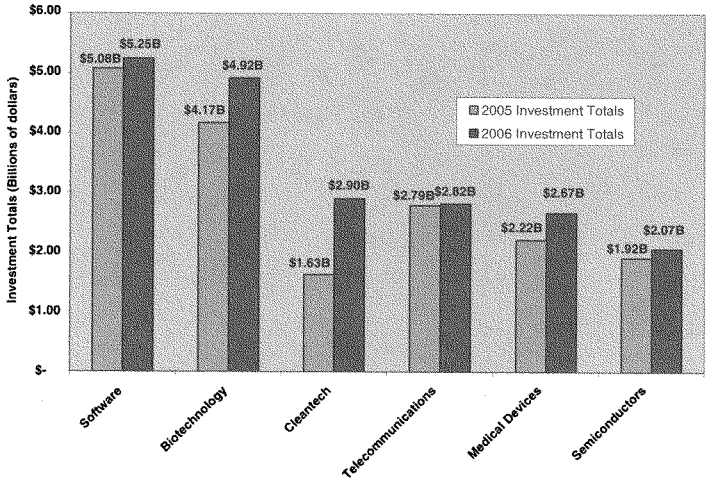
valuable new products and solutions to the market place. At Mayfield Fund, we funded companies such as Atari, Silicon Graphics, Compaq, 3Com, Genentech, Amgen and over 100 hundred other public companies that are examples of this kind of success. In 1990 Mayfield led the second round investment in Sandisk. There were few cell phones by today's standards, no digital cameras, no MP3 players, no Blackberries; a slower, simpler time. All these markets and more were enabled by Flash Memory technology created by the founding team. I suspect there are few of us here who haven't purchased a device with the Sandisk name on it, or a device with Sandisk memory in it. Mayfield was the founding investor in Millennium Pharmaceuticals, which was the pioneering company in genetic design of pharmaceuticals based on an individual's reaction to disease at the molecular level. In the early 1990's, Mayfield funded Heartstream, the manufacturer of the defibrillator machines found now in virtually every public building and every airport. When this company was started, it took a special truck, a suitcase sized $10,000+ machine, and specially trained technicians to save a life. Today you can buy one on Amazon.com for $1100.

Mayfield Fund and the Venture industry have seen the unfolding of the semiconductor, software, medical device biotechnology, computer, networking and communications industries, creating millions of jobs and trillions of dollars in revenue.

Cleantech has some important similarities to these success stories, and some differences. Cumulative venture investment in the Cleantech sector of venture investing from 1999 through 2006 totaled $11.1 billion.[i] So though it is early times in Cleantech investing, by historical standards we think there are encouraging signs for economic growth and job creation.

2006 was a banner year for the cleantech industry – with total venture investments surpassing those of the medical devices, telecommunications, and semiconductor sectors – all of which it had trailed in 2005. Venture investments in cleantech firms in North America totaled $2.9 billion, a 78 percent increase over the same total in 2005, and a 243 percent increase since 2001. This total also represented 11 percent of all North American venture capital investments for the year ($27.0 billion),[ii] making cleantech the third largest venture capital category – after only software and biotechnology.

Top 6 North American Venture Capital Industries, 2005 to 2006 (Billions of dollars)



In fact, since the economic downturn of 2000-2001, cleantech is one of the few U.S. industries to experience real growth in venture investments. While U.S. venture capital investments as a whole were off by 33 percent in 2006 compared to 2001, investments in American cleantech companies were up 243 percent in that time – more than two and a half times the growth rate of the next strongest industry (electronics/instrumentation) over that period.[iii]

So let's define Cleantech. The cleantech industry encompasses a broad range of products and services, from alternative energy generation to wastewater treatment to more resource-efficient industrial processes. Although some of these industries are very different, all share a common thread: they use new, innovative technology to create products and services that compete favorably on price and performance while reducing humankind's impact on the environment. To be considered "cleantech," products and services must:

- Optimize use of natural resources, offering a cleaner or less wasteful alternative to traditional products and services;
- Have their genesis in an innovative or novel technology or application;
- Add economic value compared to traditional alternatives.

The eleven cleantech categories, as defined by the Cleantech Venture Network, are[1]:

- Energy Generation
- Energy Storage
- Energy Infrastructure
- Energy Efficiency
- Transportation
- Water & Wastewater
- Air & Environment
- Materials
- Manufacturing/Industrial
- Agriculture
- Recycling & Waste

Some findings from the E2 Cleantech Report of 2007[iv] show real progress:

Finding 1: Growth in cleantech accelerated in 2006, with significant activity in the public markets.

In 2006, cleantech became the third-largest North American venture capital investment category (11 percent of all venture investments), behind software and biotechnology. Total North American venture capital invested in cleantech companies reached $2.9 billion in 2006, an increase of 78 percent over the $1.6 billion invested in 2005.

A significant increase in investments during the second and third quarters of 2006 was driven by capital targeted for companies moving into production. Cilion, Altra, Bloom Energy, Renewable Energy Group, and Nanosolar—all of which represent new renewable energy technology or biofuels—collectively accounted for more than $600 million in investment in 2006. But this boom can also pose challenges: Companies with new technologies have difficulty accessing capital for manufacturing build-outs. While established technologies such as corn ethanol can rely on debt financing, the first thin film solar or cellulosic ethanol facilities cannot as readily access debt financing because of the higher risks associated with first production facilities. These companies are forced to either raise additional equity capital and/or look to government assistance. As part of the 2005 Energy Act, the Department of Energy granted six cellulosic facilities special financing of up to $385 million to help build their first production facilities that, in aggregate, should reach 130 million gallons per year.[v]

[1] Environmental Information Technology (IT) and Enabling Technologies had also been considered cleantech categories by the Cleantech Venture Network until October 2006.

Cleantech is now an established investment category in the public markets. There are multiple stock indices including the Cleantech Capital Indices (CTIUS), WilderHill's ECO, Ardour Capital's Alternative Energy Indexes (e.g. AGINA, AGIGL), and Clean Edge's CELS and CLEN indexes. The 45 public companies that make up the Cleantech Index (CTIUS) have an aggregate market capitalization of over $300 billion. The performance of CTIUS over the past two years has been strong. In the two years through April 23, 2007, CTIUS has risen 38.9 percent, from 850 to 1180.6. This growth outpaced that of the S&P 500 Index (+28.6%), the NASDAQ Index (+29.9%), and the Dow Jones Industrial Average (+26.1%) over that period. After Sunpower and Suntech went public in late 2005, no fewer than seven photovoltaics companies (Canadian Solar, First Solar, PowerFilm, Akeena Solar, ReneSola, Trina Solar Limited, and Solarfun Power Holdings) went public in 2006. Recent IPOs in the biofuels sector have included Aventine Renewable Energy, Pacific Ethanol, Verasun, and U.S. BioEnergy. Perhaps because of this robust IPO market and the increase in publicly traded companies, the past two years in cleantech investing has moved from a specialty area of investment to one with broad participation from all major venture capital firms.

Finding 2: Energy prices, entrepreneurial talent, and advances in technology are industry factors accelerating growth.

Several important factors accelerated cleantech's growth in 2006:

- Sustained high oil prices have driven investor interest in alternative fuels. Most alternative fuel business plans are designed to compete with oil prices above $40 to $45 per barrel.
- As the cleantech market matures, it is attracting entrepreneurial management talent from other venture sectors – especially from information technology and biotechnology. These experienced entrepreneurs make it both easier to attract investments and more likely the company will develop into a viable business.
- Advances in technologies have been the basis for many new companies, including nano-materials used in thin-film solar and new chemistry in battery technologies.

Finding 3: Public policies at the national and state level have accelerated cleantech growth.

National and state policies have provided early foundations for many cleantech sectors, although investors do not expect those policies to continue in the long term. While the federal government has ramped up its efforts to promote ethanol, the current boom is primarily the result of states rapidly phasing out the MTBE gasoline additive and replacing it with ethanol. Venture activity in corn and cellulosic ethanol was a significant portion of investment growth in 2006, and investment in renewable electricity has been

driven primarily by state renewable portfolio standards. Policies that provide long-term certainty are the most successful at driving business investment.

Finding 4: Climate change is beginning to influence growth in cleantech.

Many of the biggest news stories of the past few years have been tied directly to extreme weather phenomena – from disastrous hurricanes to record droughts, wildfires, heat waves, and melting polar icecaps. The public has grown increasingly aware of environmental issues, judging by public opinion polls showing rising public concern about global warming and energy security. Investors, sensing the level of public interest in these stories – and therefore an opportunity in the market – are beginning to invest in industries that reduce human impacts on the ecosystem. Climate change policies will play a key role in the growth of cleantech as it becomes increasingly apparent that products and processes that reduce greenhouse gases will see increased demand.

Finding 5: Cleantech can create thousands of new jobs.

Analysis from the University of California at Berkeley[vi] concluded "the renewable energy sector generates more jobs per megawatt of power installed, per unit of energy produced, and per dollar of investment than the fossil-fuel-based energy sector." E2's own analysis found that every $100 million in venture investment generates an average of 2,700 new jobs. We estimate additional U.S. cleantech investment between 2007 and 2010 will be between $14 billion and $19 billion, resulting in 400,000 to 500,000 new jobs. If one uses the data from the National Venture Capital Association of 3,500 jobs per $100 million, the job figure could be as much as 665,000 jobs.

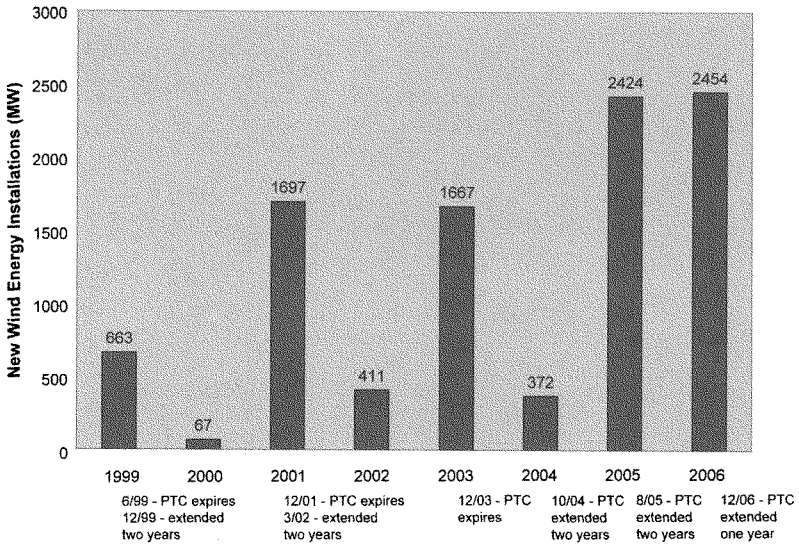
Lots of good news for the industry, and much remains to be done. In spite of the many steps that have been taken in support of the cleantech industry, barriers still remain, keeping it from growing fast enough to head off the climate crisis. The most common barriers are inconsistent policy, long term subsidies for conventional industries, and trade barriers.

Although government agencies play key regulatory roles in some venture backed industries, they have generally been even handed (in the case of the FDA and Biopharmaceutical approvals) or an agent of change for the future (in the case of the breakup of ATT in the 1970's, creating competition to the benefit of the economy, consumers and employees. The energy industry is different as the existing infrastructure protects the existing companies and the status quo. For example, customer do not directly chose the source of their electricity. Their electric utility company makes that choice for them.

We did a survey of investors in Cleantech, and among the investors we surveyed, the most often cited complaint about the current regulatory environment surrounding cleantech was the inconsistency and unpredictability of policies affecting the industry. In an open-ended question about industry barriers, 37 percent of our survey respondents volunteered their strong desire for a long-term, predictable approach to policymaking in this arena. As one investor noted, "If the federal policy is unclear or inconsistent, it introduces an element of risk that detracts from the attractiveness of a potential investment. If a federal policy is supportive and appears stable, it makes the investment more attractive." It appeared to be the group consensus that a less than perfect – but predictable – policy would be preferred over a better policy that comes and goes and can't be relied on.

Take the wind energy sector as an example. The renewable energy Production Tax Credit (PTC) is equally important to the success of the wind energy industry, which faces both economic and technical hurdles in competing with traditional fossil power sources. But unlike the VEETC and the ethanol import tariff, which have remained in place for many years, the PTC has suffered a yo-yo like fate, lapsing and being renewed approximately every two years – to the consternation of investors and companies, who find themselves unable to plan ahead in such an uncertain environment. As a result of this policy uncertainty, the wind industry has experienced a dramatic boom-bust cycle, as the figure below demonstrates.

The Production Tax Credit and its Impact on Wind Energy Installations



Source: Union of Concerned Scientists and American Wind Energy Association

Another barrier that investors mentioned regularly in the survey (27 percent of the investors surveyed discussed it) is the fact that cleantech products aren't playing on a level playing field with traditional alternatives. These respondents believe that conventional technologies (e.g. fossil fuels) regularly receive large government subsidies that give them a price advantage, even though these technologies have been mainstream for decades. (According to the U.S. Government Accountability Office, the petroleum industry alone received as much as $150 billion in tax incentives between 1968 and 2000.[vii]) One investor suggested "*corporate welfare for larger companies provides a hidden subsidy to non-cleantech companies. Provide equal subsidies for all technologies, or provide none. Let market forces decide the best application of innovation.*"

While the relatively modest subsidies and incentives that the cleantech industry receives always receive intense scrutiny, the large, long-term subsidies that conventional industries are given are more often taken for granted. Investors were not, however,

arguing for large incentives to prop up the industry. As Bill Reichert, Managing Director of Garage Technology Ventures said, "*The investment has to make sense independent of the public policy or the subsidy or the environmental fad of the month.*"

As the investors in our survey noted, cleantech products are frequently at a competitive disadvantage compared to conventional products. In addition to receiving significant subsidies, conventional products generally waste more natural resources and emit more pollution than cleantech products, thus imposing a cost on society that is not reflected in their price tags. In order to help level the playing field the prices of products need to better reflect their true economic costs to society, thereby sending a signal to consumers about the real effects of their choices.

Congress needs to consider an integrated set of policies which will both address climate change and will stimulate private investment to provide the solutions. I will briefly mention three important policies:

1. Mandatory National Carbon Cap

A mandatory, comprehensive national cap on greenhouse gas emissions, coupled with an emissions trading market, would immediately place a value on the release of carbon dioxide and other greenhouse gases, rewarding those companies that already operate in a clean and efficient manner, and forcing those companies that do not to improve their performances. More importantly, any changes that industry would make to reduce its environmental footprint and come into compliance with the cap would be done efficiently. By establishing an economy-wide cap on greenhouse gases – without specifying specific technologies or strategies – the market would naturally find the most cost-effective responses, whether by purchasing emissions credits, becoming more efficient, or altering the materials or processes used. Thus it should come as no surprise that 59 percent of respondents in our survey (17 of 29) said a national mandatory cap-and-trade system would be critical or important in influencing their investment decisions.

When ten major U.S. corporations[2] joined forces with four environmental advocacy groups in January to form the U.S. Climate Action Partnership (USCAP) and called on Congress to quickly pass legislation to tackle global climate change, it became clear that a significant, growing portion of U.S. businesses believe a carbon cap is necessary for U.S. competitiveness. USCAP, whose corporate members have a combined market capitalization of over $850 billion and whose non-profit groups have well over one million members worldwide, specifically called for a mandatory cap-and-trade program, along with an accelerated technology research, development and demonstration program,

[2] This group has since been joined by ConocoPhilips, the third largest U.S. oil company and second largest U.S. oil refiner, with a market capitalization of $116 billion.

and diplomatic efforts to convince other countries to follow suit.[viii] As of July, USCAP had grown to 29 members organizations.

The unprecedented action of business leaders, including those from the utility industry, proactively and voluntarily seeking government regulation has been repeated several times since the January 2007 press conference. In March 2007, under the leadership of CERES, more than 50 major institutional investors with combined funds under management exceeding $4 trillion signed a statement asking Congress to impose clear, consistent climate change regulations to help them mitigate climate change risks. Because in addition to making them more competitive globally, a national carbon standard would allow American companies to avoid having to navigate a chaotic maze of state-by-state climate policies. "Without national policies, the competitiveness of American business will be compromised. We don't think we can wait," said Fred Buenrostro, Jr., CEO of CalPERS, the country's largest public pension fund.[ix]

One week prior to the March 2007 CERES announcement, a bipartisan group of Silicon Valley venture capitalists and entrepreneurs testified in Congress about the need for greater federal tax incentives and research funding in cleantech. With a sense of urgency, they also recommended consolidating all federal energy research into a National Institute of Energy that could support public-private partnerships, in the model of the medical sciences' National Institute of Health. "*We are in a crisis, and we have to translate this crisis into opportunity. Missing this moment would be horrible.*" said Aart de Geus, CEO of Synopsys, an electronic design automation company.[x] These business leaders are also part of a bipartisan group of dozens of technology company CEOs known as TechNet, which also advocates establishing a national renewable portfolio standard, a national renewable energy credit marketplace, and a system of long-term, declining incentives for clean technologies.[xi]

2. National Renewable Energy Standard

California's experience over the past few decades demonstrates that, far from hurting an economy, well-designed cleantech regulations – such as California's advanced energy efficiency and air quality regulations – can actually stimulate innovation, leading to new economic growth. Knowing that, it becomes clear why 65 percent of the investors we surveyed (19 of 29) said a national renewable energy standard would be a critical or important factor in their investment decisions. In the increasingly carbon-constrained world in which we live, improving the performance of our renewable energy technologies through innovation will be extremely important – not only for our environment but for our economic competitiveness as well. A national renewable energy standard could be a major contributor in driving this innovation in next-generation clean energy technologies.

3. More Public R&D Investment

While growth of the clean technologies would benefit from programs that increase demand (for example a cap-and-trade system or renewable portfolio standard), the industry still needs strong investment in basic R&D. Since the energy crises of the 1970s, federal spending on energy research is down significantly, with private investments making up some, but not all, of the difference. Fortunately for the cleantech industry, public and private investments in complementary industries such as biotechnology, semiconductors, and software have been quite strong in recent years, and there is a high degree of technical knowledge spillover from these industries to cleantech sectors. In fact, some of the same people who were involved in startup companies in those other industries in the 1990s are now getting involved in ethanol and photovoltaics companies, among others.[xii]

Still, the success of the cleantech industry should not depend on spillover from its cousin industries, or from private investment alone. Public investment in cleantech research is also crucial, for several reasons:

- In its magnitude alone, it can accelerate the pace of research innovation and development.
- It helps to reassure private investors that this area is important to the public, is worth investing in, and will receive real public support. As one investor in our survey said, public support from individual states "sends a message to entrepreneurs, investors and others that the state intends to create a business environment that is supportive of cleantech."

Public investment in basic R&D is still necessary to growing new industries of the future. The investors participating in our survey noted that a cleantech product must be able to stand on its own merits, and while they would not invest in a company solely on the basis of government support or subsidies, many noted that government investments are important and would encourage a higher level of private investing. For instance, 59 percent of respondents (17 of 29) said that a government program that matched private investment dollars would be critical or important to their investment decisions. One investor even noted that his fund's specific investing strategy is to "*leverage publicly funded research at labs and universities, so greater investment on the federal level in that research would be beneficial, as long as it is focused on commercial outcomes.*"

The Importance of Implementation

Aside from the policies themselves, the manner in which they are implemented is crucial to their success. For instance, it's very important that when a carbon cap (or renewable energy standard or other program) is enacted nationwide, that measure should not preempt states from going even further. If particular states or regions want to enact more

stringent carbon caps, or more aggressive renewable portfolio (or fuel) standards this will only improve the country's environmental health and competitiveness in the cleantech marketplace – it would cost other regions nothing.

The consistency and reliability of the federal policies that are enacted is another important factor. As mentioned earlier, 37 percent of the investors participating in our survey (11 of 30) responded to an open-ended question about the barriers facing the industry by stating the necessity of having predictable, long-term policies in place. This is a strong concern of many stakeholders in the industry. Given that many cleantech companies must compete against subsidized conventional alternatives, having supportive policies stripped away unexpectedly can wreak havoc on them. This is plainly evident in the wind installations and production tax credit. Entrepreneurs and investors both need to have the ability to plan ahead beyond the end of the current fiscal year.

There are questions often asked when these topics are discussed, I will try to anticipate a few of these.

1. It seems like investment and activity in Cleantech is growing and healthy, so why should the government intervene?

Because we are in a crisis. A dramatic decrease of carbon released into our climate has to happen quickly. Without intervention, our auto industry has made no progress at all in increasing mileage and decreasing emissions in decades, while Japan and the European community already meet or exceed the 35 mpg standards proposed for the United States to meet by 2018 (the most aggressive proposal)! This has helped neither the environment, nor the American auto industry. While California has passed legislation requiring power it buys to be generated through clean technology, there are those in Congress who would like to see this overturned, as it is more aggressive than what other states might demand. California's Greenhouse Gases Emission Performance Standard Act (SB1368) that became law on January 1, directs the California Energy Commission to set greenhouse gas emissions standards for the baseload electricity used by the state (whether generated in-state or imported from out of state).[xiii] The law effectively prevents the state from signing any long-term procurement contracts for traditional coal-fired power, or any electricity that comes from sources that emit more than a clean, efficient natural gas power plant. (However, the law doesn't explicitly ban any particular form of energy generation – electricity from coal plants with carbon sequestration, for example, would still be able to be sold in the state.)

While almost no electricity from coal is currently generated inside California, the state still imports a fair amount of coal-generated power from outside its borders – and at last count, dozens of new coal power plants were being planned for construction in western

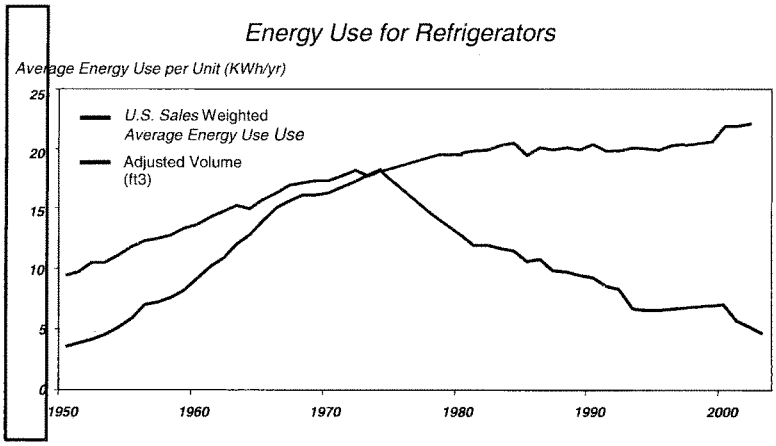
states, many with the aim of selling their power in the growing California electricity market. But SB1368 sends a strong signal to western energy markets, aiming to discourage these large, long-term investments in highly polluting technologies. As a result, cleaner production technologies, like geothermal, wind, or small hydro, will receive a significant competitive advantage in the state.

2. Is this just a bubble that will blow away and things will return to normal?

No, the world has changed. In the last 10 years over 400 million people have emerged from poverty in India and China. They want cars, refrigerators. They want to travel and have air conditioning when it is too hot. They want to live like us, and to do that they need to have as much energy as we use. Meanwhile, the industrialized world continues to use as much energy as ever. Competition for resources has irrevocably changed the game.

3. Will this mean that the government picks winners and losers?

No, it does not. The government did not tell automobile manufacturers how to increase mileage when the first CAFÉ standards were set. Nor did it tell refrigerator manufacturers how to reduce their energy consumption (since those standards were set in the 1970's, energy use in refrigerators has dropped 75%, the equivalent of not building 100 to 300 power plants). But the government did tell them they HAD to meet performance standards, and they did. We recommend a declining carbon cap coupled with federal R&D in a variety of technologies. Let the market have a flatter field for competition.



4. Does this mean that every company wins with a carbon cap strategy?

Not at all. Change has always been a constant, the components of the Dow Jones Index continually have turned over since it's creation over 100 years ago and our economy thrives by creating industries that add jobs and that add value. Some companies will resist change and those that are better at adapting will replace them. The result will be a net increase in economic output and jobs and a more competitive U.S. This has always been so. Industries that expect or need the government to protect them from change cannot compete in the modern world (if in fact they ever could in any era, today there are no Railroad, Steel or Airline stocks in the Dow).

5. Should the U.S. link its carbon policy to decisions by China and India?

Only if we want to slow ourselves down. Our contribution to Global Warming is significant and needs to be reduced. California decided that an early start on climate would make the state more competitive vis-à-vis the rest of the U.S. The U.S. will be in a better position to sell cleantech to China and India if we get our country moving first. As we continue to show that our policies create a more robust economy and a cleaner environment, they will rush to join us. They already have a significant appetite to buy cleantech products and services, and they are now buying some of them from countries other than us. The U.S. is no longer the world leader in two important clean energy fields – it ranks third in installed wind power production behind Denmark and Spain,[xiv] and third in photovoltaic power installed behind Germany and Japan. We can regain market leadership with a simple policy of a declining carbon cap coupled with federal R&D is a variety of technologies.

6. What else should we be doing?

We need to be the people the world has been waiting for, the people our children will say made the decisions that gave their children a safer and healthier place to live. We should not be the people who pass the buck, the people our parents warned us about.

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[i] According to the Cleantech Capital Group, $7.4B was invested from 1999 through Q2 2005. Q3 2005 was $.425B. Q4 2005 was $.502B and 2006 was $2.9B for a total of $11.1B.

[ii] Cleantech Venture Network; PricewaterhouseCoopers/National Venture Capital Association MoneyTree™ Report (CVN; MoneyTree). (2007). http://www.pwcmoneytree.com/exhibits/MoneyTree_4Q2006_Final.pdf.

[iii] Ibid CVN; MoneyTree

[iv] Cleantech Venture Capital: How Public Policy Has Stimulated Private Investment, May 30, 2007 http://www.e2.org/jsp/controller?docId=12959

[v] "DOE Selects Six Cellulosic Ethanol Plants for up to $385 Million in Federal Funding" http://www.energy.gov/news/4827.htm

[vi] Kammen, D., Kapadia, K., & Fripp, M. "Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?" Energy and Resources Group/Goldman School of Public Policy at University of California, Berkeley. (2004). http://rael.berkeley.edu/files/2004/Kammen-Renewable-Jobs-2004.pdf.

[vii] "Tax Incentives for Petroleum and Ethanol Fuels." U.S. Government Accountability Office. (September 25, 2000). http://www.gao.gov/archive/2000/rc00301r.pdf.

[viii] "Major Businesses and Environmental Leaders Unite to Call for Swift Action on Global Climate Change." (Press Release). United States Climate Action Partnership. (January 22, 2007). http://www.us-cap.org/media/release.pdf.

[ix] Herbst, M. "Investors Call on Congress to Go Green." Business Week. (March 20, 2007). http://www.businessweek.com/bwdaily/dnflash/content/mar2007/db20070320_535194.htm?chan=top+news_top+news+index_top+story.

[x] Davies, F. "Silicon Valley Leaders: Political Climate Right for 'Green Tech.'" San Jose Mercury News. (March 15, 2007). http://www.mercurynews.com/search/ci_5440875.

[xi] "Green Technologies: An Innovation Agenda for America." TechNet. (2007). http://www.technet.org/resources/GreenTechReport.pdf.

[xii] Richtel, M. "Start-up Fervor Shifts to Energy in Silicon Valley." The New York Times. (March 14, 2007). http://www.nytimes.com/2007/03/14/technology/14valley.html?ex=1176609600&en=678b72b953a2ae32&ei=5070.

[xiii] "Senate Bill No. 1368." California Energy Commission. (September 29, 2006). http://www.energy.ca.gov/ghgstandards/documents/sb_1368_bill_20060929_chaptered.pdf.

[xiv] World Wind Energy Association. (2007). http://www.wwindea.org/home/index.php?option=com_content&task=view&id=167&Itemid=43

The CHAIRMAN. Great. We thank you, sir, very much. Our next witness is Ms. Barbara Lockwood, who is the manager of Renewable Energy for the Arizona Public Service Company. Welcome.

STATEMENT OF BARBARA D. LOCKWOOD, P.E., MANAGER, RENEWABLE ENERGY, ARIZONA PUBLIC SERVICE COMPANY

Ms. LOCKWOOD. Thank you. Mr. Chairman and members of the committee, thank you for the opportunity to provide APS's perspective on the economic benefits of renewable energy. As Congressman Shadegg mentioned, Arizona is the second fastest growing state in the country, growing at three times the national average. APS has more than a million customers who at their peak consume over 7,000 megawatts of electricity. And that electricity demand is growing at a rate of hundreds of megawatts each and every year.

In Arizona, our most abundant renewable resource is sunshine. And APS is looking for ways to put the sun to work providing electricity. APS is committed to making Arizona the solar capital of the world.

The focus of my comments today are on a particular type of solar technology called concentrating solar power, or CSP, which is different than the photovoltaic systems or solar panels that you typically hear about. APS recently announced the Solana Generating Station. Solana is a 280 megawatt solar power plant to be located just outside of Phoenix, Arizona. APS has signed a long-term contract with Abengoa Solar, the project developer and owner, for all of the electricity generated by this plant.

If operating today, Solana would be the largest solar power plant in the world. The plant will use nearly three square miles of parabolic trough mirrors, and operating at full capacity, the plant will provide enough electricity for 70,000 homes. One of the most important aspects of this technology is its ability to capture and store energy for later use. By using large insulated tanks filled with molten salt, heat captured during the day can be stored and used to produce electricity when the sun is no longer shining.

The value of this can't be underestimated. Because it can provide energy even after the sun has set, this technology provides the maximum value, and it also provides reliability for APS and its customers. Solana also provides significant economic benefits to the state of Arizona. The Solana Generating Station will provide 1,500 construction jobs and 85 permanent operations jobs. But that's not the total economic impact. All totaled, Solana will result in over a billion dollars in economic development for the state of Arizona.

Today the single biggest obstacle to the success of Solana is the potential expiration of the 30 percent federal investment tax credit. Without this tax credit, Solana is simply not affordable today. I also need to be clear that a one or two-year extension of the ITC is not sufficient. While it might not be preferable, it is usually acceptable for small scale solar projects and for wind projects. But large scale solar is different. It takes about three to four years to permit and construct a plant like Solana, and we can't begin building it until we know when it's finished it's going to be eligible for the 30 percent investment tax credit. If a long-term extension of the investment tax credit is not granted, Solana will not be built.

If the ITC is extended for a sufficient period of time, there will be many more plants like Solana in Arizona and in the desert Southwest developed in the next five to ten years. If not, the industry will lose its momentum and no large scale solar plants will be built. The future of large scale solar depends on getting those first few plants into operation.

Thank you, Mr. Chairman and members of the committee for the opportunity to share this information with you.

[The prepared statement of Ms. Barbara D. Lockwood follows:]

Testimony of Barbara D. Lockwood, P.E.
Manager, Renewable Energy
Arizona Public Service Company

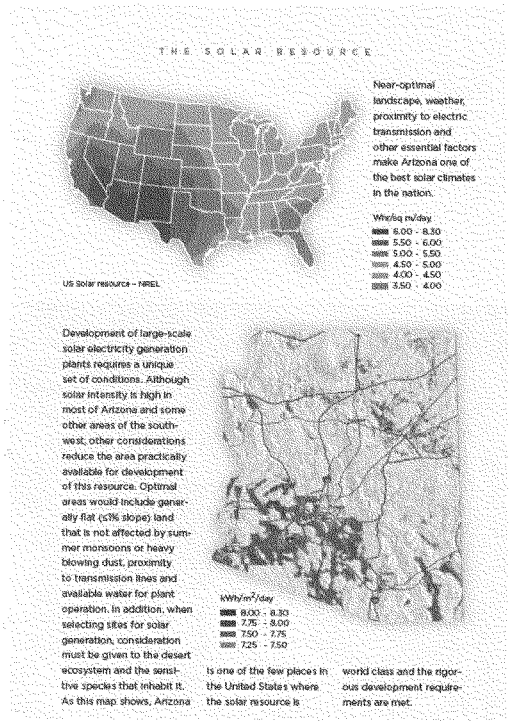
Before the U.S. House of Representatives
Select Committee on Energy Independence and Global Warming
"Blowing in the Wind: Renewable Energy as the Answer to an Economy Adrift"
March 6, 2008

Mr. Chairman and Members of the Committee, thank you for the opportunity to provide Arizona Public Service Company's (APS') perspective on the economic benefits of renewable energy. My comments will focus on the opportunity that large-scale solar power plants provides for clean, reliable electricity, and the one significant challenge that stands in the way.

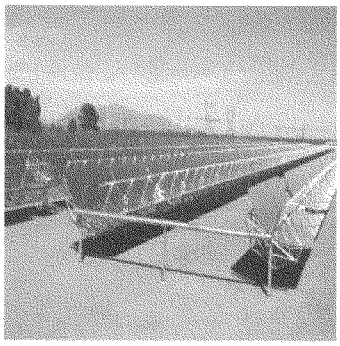
APS is the largest and longest serving electric power utility in Arizona. Arizona is the second fastest growing state in the country, and APS has more than a million customers who, at their peak energy consumption, use more than 7,000 megawatts of electricity. By 2025, APS will have nearly two million customers demanding over 13,000 megawatts of electricity. To meet this rapid growth in electricity demand, APS is investing $1 billion a year in infrastructure. That number does not include additional generation sources. For APS alone, our peak demand is growing at rate of 250 to 300 megawatts per year, or the equivalent of one medium-sized natural gas plant each and every year. Meeting the growing needs of our customers is both a challenge and an opportunity.

In Arizona, our most abundant renewable resource is sunshine. The solar resource in Arizona is virtually unlimited, with more than 300 days of sunshine each year. In addition, Arizona has sizeable quantities of wide-open, flat landscape that is ideal for the installation of large-scale solar equipment. Among the most important factors in considering a resource for electricity production is the reliability of the fuel. Arizona's solar climate provides a resource that is both dependable and predictable.

APS is committed to making Arizona the solar capital of the world and bringing affordable renewable energy to all its customers. A balanced renewable energy portfolio including solar, wind, geothermal and biomass/biogas resources is fundamental to our operating strategy. For the past two decades, APS has worked with the solar industry and researchers around the U.S. and the world to bring lower cost and reliable solar electricity to our customers. In 1988, the APS Solar Technology And Research (STAR) center was developed to support the advancement of solar resources, including field operation of both photovoltaic and concentrating solar technologies. In addition to STAR, APS currently has over five megawatts of photovoltaic power plants in operation providing reliable solar energy to our customers.



APS has also supported the advancement of concentrating solar power (CSP). These technologies are "thermal electric systems" that use solar heat to drive generators and engines. CSP thermal systems include solar trough concentrator systems and central receiver (power tower) systems that use many mirrors to focus light on a central solar collector. CSP also include solar dish Stirling systems and other advanced solar concepts.



In fact, APS constructed the first commercial CSP plant in the United States in almost 20years. The Saguaro Solar Power Plant, which came on-line in 2006, is a one megawatt parabolic trough facility located just north of Tucson at Red Rock, Arizona. This plant has provided critical learning for APS, the CSP industry, and researchers. While small in size, it has facilitated new interest in CSP around the country and the world.

But that was just the beginning of our entrance into commercial CSP. Also in 2006, APS stepped forward to lead a coalition of southwestern utilities interested in CSP. The Joint Development Group is a consortium of seven entities exploring the possibility of a 250 megawatt CSP project to be located in Arizona or Nevada. Acting as project coordinator, APS issued a request for proposals in December of 2007. If all goes well, the consortium project could be selected this summer.

But our most significant step to date is the announcement on February 21, 2008, of the Solana Generating Station. Solana is a 280 megawatt solar power plant to be located 70 miles southwest of Phoenix near Gila Bend, Arizona. APS has signed a long-term contract with Abengoa Solar, project developer and owner, for 100% of the electricity generated by Solana. Solana is the Spanish word for "sunny place."

If operating today, Solana would be the largest solar power plant in the world. The plant will use nearly three square miles of parabolic trough mirrors and receiver pipes, coupled with two 140-megawatt steam generators. Operating at full capacity, the plant will produce enough electricity to power 70,000 Arizona homes.

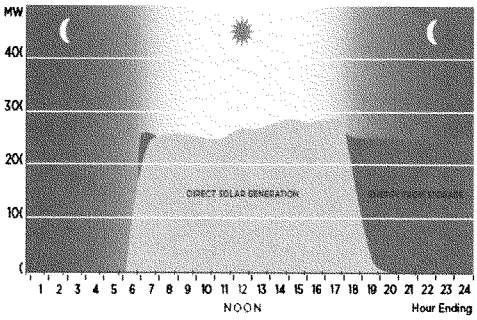
Solana also provides significant economic benefits to the state of Arizona. The Solana Generating Station will provide 1,500 construction jobs between 2008 and 2011 and 85 permanent operations jobs. While those positions are related directly to Solana, the plant's economic impact is much greater. Local businesses will benefit from increased revenues from the sale of general goods and services that the plant staff and construction personnel will need. These goods and services include everything from technical services such as welding, to restaurants, auto repair and housing. Studies have estimated the total

dollar impact during construction of a plant like Solana to be roughly equal to the total capital investment in the plant plus the creation of an additional 11,000 to 15,000 jobs. Solana will also generate between $300 million and $400 million in tax revenue over the 30 year life of the plant. All total, Solana will result in over $1 billion in economic development for the Arizona economy.

Finally, Solana is an emission-free source of electricity, avoiding nearly 500,000 tons of carbon dioxide, 1,065 tons of nitrogen oxides, and 520 tons of sulfur dioxide each year. It is the equivalent of removing 80,000 cars from the road each year. Solana will also use 75% less water than the current agricultural usage of the land.

APS selected Abengoa Solar as its partner for Solana because of its track record as a solar developer, its critical operational experience and a reputation for meeting contractual obligations.

One of the most important aspects of Solana is its ability to capture and store solar energy for later use. By incorporating large insulated tanks filled with molten salt, heat captured during the day can be stored and used to produce electricity when the sun is no longer shining. The molten salt and heavily insulated tanks are able to retain heat with very high efficiency, and the stored heat can then be extracted in the evening or even the following day to create electricity.



The stored heat not only increases the total amount of electricity generated, it also adds specific operating benefits for APS. The ability to use stored heat on demand, also referred to as "dispatching," allows APS to respond to customer usage patterns and emergency energy needs more effectively. Most southwest utilities experience their highest customer demand during the summer months. While the power need is substantial in the middle of the day, peak energy demand occurs in the late afternoon and into the early evening hours. Because it can provide energy even after the sun has set, the solar

trough with thermal energy storage provides the maximum value for APS and its customers.

Diversification of generation resources is critical to maintaining a reliable electric system and concentrating solar power provides a significant opportunity to diversify energy resources. In addition, the costs to construct and maintain concentrating solar power plants have declined while at the same time equipment and labor costs, rising fuel prices and emissions concerns are increasing the risks of conventional resources.

APS also recognizes that renewable energy strategies will become even more important under the prospects of carbon legislation. With zero carbon emissions, energy from solar power provides one method of addressing concerns around global warming while continuing to provide reliable electricity to our customers.

And Solana is not the end of our interest in CSP. APS is currently engaged in a formal dialogue with our regulators, stakeholders and customers about our future energy sources. We are exploring the availability, cost, regulatory and policy implications associated with many different types of resources including nuclear, natural gas, coal, energy efficiency and renewable energy. One of several scenarios under discussion is one where CSP plays a central role, adding 1,350 megawatts by 2020.

CSP, in particular the solar trough, is proven, reliable technology. There are no technical barriers to deployment of this technology today, and APS is aggressively exploring the potential.

The biggest obstacle to the success of utility-scale solar, including Solana, is the potential expiration of the federal Investment Tax Credit (ITC). Solana, and projects like Solana, became possible when the federal ITC for solar systems was increased from 10% to 30% in 2006. While large-scale solar is still more expensive than conventional resources, the 30% investment tax credit decreased the cost sufficient to make these projects a reasonable option. Without these tax credits, large scale solar projects, including Solana, are simply not affordable today. As you know, the 30% ITC is scheduled to expire at the end of 2008. The approval, permitting and construction of the Solana Generating Station will take three to four years to complete. The Solana project also requires well over a billion in capital investment. APS, Abengoa Solar, and the financial institutions providing funding for Solana require certainty that Solana will be

eligible for the ITC once operational. *If a long-term extension of the ITC is not granted, Solana will not be completed.*

A different federal tax credit, the production tax credit (PTC), has spurred significant development for other renewable energy resources, most notably wind energy. The PTC has been extended five times since its introduction in 1992 and each extension was for one to two years. Although the wind industry has worked toward longer term extensions, wind energy projects, and smaller scale solar projects, have much shorter time frames for construction, which makes short term extensions of the PTC acceptable, if not preferable. Although the solar ITC is typically packaged with the PTC in discussions of extensions, large-scale solar has very different needs related to tax credits. *A one or two year extension of the solar ITC is simply not sufficient to make large scale solar projects like Solana a reality.* In fact, a one or two year extension of the Solar ITC may effectively cancel the project. Large scale solar has little hope of realizing its potential without a long-term extension of the ITC. APS believes an eight year extension is optimal. Eight years should be sufficient to get a number of large scale solar facilities completed. It is also long enough to establish the supporting industries like mirror and receiver manufacturing in the United States. Once the industry gains a foothold, prices will decline and incentives will no longer be necessary.

Another critical aspect of the ITC is the fact that it is not available to public utilities. The restriction needlessly narrows application of the credit and is unfair to U.S. citizens because the vast majority purchase power from a public utility, as it is defined by the tax code. This current policy forces a third-party owner to take advantage of the ITC and it creates unnecessary uncertainty and costs to the system. It requires the utility and regional grid to consider the operational and financial risks inherent in any third party relationship thus potentially affecting the utility operating strategies. APS is managing these risks with Solana, but it creates a suboptimum situation when it is the only strategy available.

Clearly, the potential for utility scale solar electricity is enormous. If, and only if, the ITC is given a long term extension, I predict we will see several thousand megawatts of utility scale solar developed in the next 5 to 10 years. At least seven major projects have been announced since 2006. If the ITC is not extended for a sufficiently long period

of time, the industry will lose its precious momentum and no large scale solar plants are likely to be constructed. The future of large scale solar depends heavily extending the ITC and getting those first few plants in operation.

Thank you, Mr. Chairman and Members of the Committee for the opportunity to share these observations and opinions with you.

The CHAIRMAN. Thank you, Ms. Lockwood, very much. Our next witness is Ms. Bianca Jagger, who is the Chair of the World Future Council. Welcome. Could you move the microphone up a little bit closer and turn it on.

STATEMENT OF BIANCA JAGGER, CHAIR, THE WORLD FUTURE COUNCIL

Ms. JAGGER. Thank you, Mr. Chairman, and thank you for organizing this very important hearing. It is an honor and a privilege to be here. I have heard some very important testimony about renewable energy and what has been done in the United States. Perhaps I'd like to talk about the threat of global climate disaster that is no longer out for debate, and therefore, renewable energy becomes a must and not just a question mark. The majority of scientists are in agreement.

Governments have previously been reluctant to accept this reality. However, notwithstanding all this sobering information, the agreements reached in Bali were extremely weak and inadequate. And as you know, the role that the United States played in Bali was not the most encouraging.

Climate change is the defining challenge of our age. How to meet that challenge while dealing with the already devastating consequences of floods, droughts and rising temperatures remain the great unanswered question, and the time to answer is running out. In its final report, the United Nations Intergovernmental Panel on Climate Change stated that the world must reverse the growth of greenhouse gas emissions by 2015 to avert a global climate disaster. If there is no action before 2012, that's too late, said Rajendra Pachauri, who headed the panel, which shared the Nobel Peace Prize in October with former U.S. President Al Gore. What we do in the next two to three years will depend and will determine our future.

But what should we do? I used to believe that reduced energy consumption was an important first step, accompanied by research and investment into energy efficiency and renewable energy sources. I used to believe that it would be enough to encourage more localized lifestyle, reducing the need for overburdened, polluting transport networks. But after reading the most recent scientific findings, I have come to realize that even if we begin each of these practices in earnest tomorrow, it is simply not enough.

The time has come to expose the myth that we can avert climate catastrophe by small measures and sticky plaster measures. In the recent assessment by the highly respected climate scientist James Hansen of the NASA Goddard Institute for Space Studies, he suggested that the IPCC report, itself alarming reading, might even be "absurdly optimistic."

For example, the often-touted "safe" figure of 3.6 degrees Fahrenheit increase in average global temperatures is in fact not safe at all. We have already experienced a rise of 1.31 Fahrenheit in average global temperatures. A rise of 3.6 Fahrenheit is three times that. Agreeing to a 3.6 Fahrenheit target does not avoid the possibility of catastrophe. On top of this, the apparently bold target of reducing emissions by 50 percent does not guarantee that the temperature increase will be limited to 3.6 degrees Fahrenheit.

Hansen estimates sea level rises of 4 to 5 meters this century due to melting ice in Greenland and Antarctica. He describes how the IPCC report fails to take geological records into account and ignores the so-called "albedo flip" property of water: "The 'albedo flip' property of ice/water provides a powerful trigger mechanism . . . a climate forcing that 'flips' the albedo of a sufficient portion of an ice sheet can spark a cataclysm."

Hansen is telling us that the poles do not melt in a linear fashion, but rather in bursts, and that if the globe warms up just a few degrees, it might be enough to trigger a catastrophic ice sheet collapse. Such a collapse would not only drown most of the world's centers of population, but would itself fuel further climate change, since less ice means less heat reflected back into space.

"The Earth's climate is remarkably sensitive to global forcings. Positive and 'amplifying' feedbacks predominate. This allows the entire planet to be whipsawed between climate states. Recent greenhouse gas emissions place the Earth perilously close to dramatic climate change that could run out of control."

"If we go beyond the point where human intervention can no longer stabilize the system, then we precipitate unstoppable runaway climate change. That will set in motion a major extinction event comparable to the five other extinction crises that the Earth has previously experienced."

This clearly demonstrates what the World Future Council, the organization I chair, is advocating. If we are serious about averting climate change catastrophe, we must think in revolutionary terms, and transform our way of life, restoring rather than destroying life on Earth. We must embark upon a global renewable energy revolution. If we are to achieve the necessary carbon reduction by 2020, we must replace our carbon-driven economy with a renewable energy economy. There is no time to debate half-measures any longer. The period in which they may have been effective has long been passed.

We have experienced an industrial revolution. We have experienced a technological revolution. It will take a global renewable energy revolution, similar in scale and consequence to those two, to avert catastrophe. As Hermann Scheer, a member of the German Bundestag and the World Future Council, said, "This cannot be achieved with the method of 'talk globally—postpone nationally,' but only with the method of 'think globally—act locally, regionally and nationally.'"

The beginning of this movement may already be underway. Some nations have begun to act, even finding great financial opportunities along the way. In Germany, pushes toward energy efficiency and renewable energy sources are spurring the economy. By 2020, every building must meet high levels of energy efficiency. The Feed-In tariffs legislation, which guarantees a preferential price for energy produced, will create 250,000 jobs.

The CHAIRMAN. Ms. Jagger, could you please summarize the statement?

Ms. JAGGER. Sure. It will be crucially important for the United States, perhaps led by individual states, to adopt Feed-In tariffs as a significant way by which to accelerate the introduction of renewable energy. The U.S. cannot continue to rely on powering its cities,

its industries, its farms and its transport systems, by energy resources for which there is ever greater global competition.

Thank you very much, Mr. Chairman.

[The prepared statement of Ms. Bianca Jagger follows:]

THE THREAT OF A GLOBAL CLIMATE DISASTER IS NO LONGER UP FOR DEBATE

BIANCA JAGGER'S TESTIMONY AT THE SELECT COMMITTEE FOR ENERGY, INDEPENDENCE AND GLOBAL WARMING

6 MARCH 2008

The threat of a global climate disaster is no longer up for debate. The majority of scientists are in agreement. Governments have previously been reluctant to accept this reality. However, notwithstanding all this sobering information, the agreements reached in Bali, were extremely weak and inadequate.

I am sure we all agree with UN Secretary General Ban Ki-moon when he says that climate change is "the defining challenge of our age". How to meet that challenge, while dealing with the already devastating consequences of floods, droughts and rising temperatures, remains the great unanswered question. And the time to answer it is running out.

In its final report, the United Nations Intergovernmental Panel on Climate Change stated that the world must reverse the growth of greenhouse gas emissions by 2015 to avert a global climate disaster. "If there's no action before 2012, that's too late," said Rajendra Pachauri, who headed the panel, which shared the Nobel Peace Prize in October with former U.S. Vice President Al Gore. "What we do in the next two to three years will determine our future."

But what should we do? I used to believe that reduced energy consumption was an important first step, accompanied by research and investment into energy efficiency and renewable energy sources. I used to believe that it would be enough to encourage more localized lifestyles, reducing the need for overburdened, polluting transport networks.

But after reading the most recent scientific findings, I have come to realise that, even if we began each of these practises in earnest tomorrow, it is simply not enough.

The time has come to expose the myth that we can avert climate catastrophe by small measures and "sticky plasters measures." In the recent assessment by the highly respected climate scientist, James Hansen of the NASA Goddard Institute for Space Studies he suggested that the IPCC report, itself alarming reading, might even be "absurdly optimistic."

For example, the often-touted "safe" figure of 2°C (3.6° F) increase in average global temperatures is in fact not safe at all. We have already experienced a rise of 0.73°C in average global temperature: a rise of 2°C is three times that. Agreeing to a 2°C target does not avoid the possibility of catastrophe. On top of this, the apparently bold target of reducing emissions by 50% does not guarantee that the temperature increase will be limited to 2°C.

Hansen estimates sea level rises of 4 to 5 metres this century due to melting ice in Greenland and Antarctica. He describes how the IPCC's report fails to take geological records into account and ignores the so-called "albedo flip" property of water:

"The 'albedo flip' property of ice/water provides a powerful trigger mechanism … A climate forcing that 'flips' the albedo of a sufficient portion of an ice sheet can spark a cataclysm."

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"The Earth's climate is remarkably sensitive to global forcings. Positive and 'amplifying' feedbacks predominate. This allows the entire planet to be whipsawed between climate states. Recent greenhouse gas emissions place the Earth perilously close to dramatic climate change that could run out of control."

George Monbiot writer and columnist for the Guardian notes that, "If Hansen is correct, to avert the meltdown that brings the Holocene to an end we require … a sort of political "albedo flip". David Wasdell, Director of the Meridian programme, in a book he co-authored called "Planet Earth, We Have A Problem," talks about the impending tipping point:

"If we go beyond the point where human intervention can no longer stabilise the system, then we precipitate unstoppable runaway climate change. That will set in motion a major extinction event comparable to the five other extinction crises that the earth has previously experienced."

I find it deeply mystifying that the vast majority of the media are still not adequately expressing the scale of the danger we face. Professor John Holdren, President of the AAAS, said in August, "We have already passed the stage of dangerous climate change. The task now is to avoid catastrophic climate change." And as George Monbiot, in an article he wrote for the Guardian in July, said: "Unaware of the causes of our good fortune, blissfully detached from their likely termination, we drift into catastrophe."

This clearly demonstrates what the World Future Council, the organisation I chair, is advocating. If we are serious about averting climate change catastrophe, we must think in revolutionary terms, and transform our way of life, restoring rather than destroying life on earth. We must embark upon a global renewable energy revolution: if we are to achieve the necessary carbon reduction by 2020, we must replace our carbon-driven economy with a renewable energy economy."

There is no time to debate half-measures any longer: the period in which they may have been effective has long since passed.

We have experienced an industrial revolution. We have experienced a technological revolution. It will take a global renewable energy revolution, similar in scale and consequence to those two, to avert catastrophe. As Hermann Scheer, member of the German Bundestag and the World

Future Council, said, "This cannot be achieved with the method of 'talk globally – postpone nationally,' but only with the method of 'think globally – act locally, regionally and nationally.

The beginnings of this movement may already be underway. Some nations have begun to act, even finding great financial opportunities along the way. In Germany, pushes toward energy efficiency and renewable energy sources are spurring the economy. By 2020, every building must meet high levels of energy efficiency. The Feed-In Tariffs legislation, which guarantees a preferential price for energy produced by renewable energy installations, has helped to create 250,000 new jobs in Germany. For an annual growth of renewable energy installed capacity of 3,000 MW. Since 2000 it has reduced Germany's C02 emissions by 100 million tonnes. It has dramatically accelerated the introduction of renewable energy in the forty-six countries and regions have now introduced variants of this legislation. It has also created important breakthroughs that are making renewable energy increasingly cost-competitive with fossil-fuel energy.

It would be crucially important for the United States – perhaps led by individual states – to adopt Feed-In Tariffs as a significant way by which to accelerate the introduction of renewable energy. The USA cannot continue to rely on powering its cities, its industries, its farms and its transport systems by energy resources for which there is ever greater global competition and which are fast running out. President Bush's emphasis on corn ethanol and nuclear power is not the solution. Already one third of America's maize crop is used for producing gas for American cars. This is pushing up food prices and threatening global food supplies. 200 times more surface area is required to produce energy from crops as compared with energy from photovoltaic cells. It makes much more sense to produce energy for homes and even for urban transport from the roofs of buildings and from solar and wind installations on the edge of cities. This process has started across Europe and it is high time that the US took the lead, once again, in the renewable energy revolution.

Meanwhile we have to face some ugly and unavoidable truths: despite the clear and urgent alarms sounded by thousands of respected scientists, the developed world continues to feed its out-of-control oil addiction. We are still locked into an inefficient, pollution-based economy, which is undermining public health and the environment, aggravating inequality and turning us into oil predators.

The rich world is causing climate change and the poor world is suffering. As climate change kicks in, the tropical and subtropical countries of Africa, South Asia and Latin America will heat up even more, their climates becoming intolerable. Droughts will affect large parts of Africa, Asia and Latin America. Melting glaciers will flood river valleys. When the floods have subsided, unprecedented droughts will occur. A poor, low-lying country like Bangladesh will find it much harder to cope with sea level rise than a rich region like Florida. Ban Ki-moon said: "Climate change will affect developing countries the most. Those who are most vulnerable are also the most at risk from this threat. Melting glaciers will trigger mountain floods and lead to water shortages in South Asia and South America. Reduced rainfall will aggravate water and food insecurity in Africa."

If current trends are allowed to continue, hundreds of millions of people in poorer countries will lose their homes as well as the land on which they grow their crops. And then there is the threat of disease and epidemics: according to Christian Aid, by the end of the century, 182 million people in sub-Saharan Africa alone could die of diseases and epidemics directly attributable to climate change.

Other species will suffer, too. The IPCC report stated that if governments fail to act, melting ice sheets could lead to rising sea levels and the extinction of entire species of animals and plants.

We must integrate the twin goals of climate care and development to avoid the race between growth and catastrophe. Global justice requires that we make personal and collective choices to use the Earth's resources prudently. We are challenged to rebalance our lifestyles to ensure that future generations have adequate natural resources, a stable climate and a healthy planet.

From climate chaos to global justice – how can such a transition be achieved? As I see it, there are two key issues.

First, the rich countries need to dramatically reduce their consumption of fossil fuels and to accelerate the development of renewable energy as the basis of a totally new energy system for the planet. Every year, we burn a million years' worth of fossil fuel deposits. This makes the unprecedented standards of living for a large portion of people in rich countries possible. Meanwhile, rapid economic growth is also disproportionately increasing the living standards of minorities in developing countries. But all this is possible only because we are running down the earth's assets – particularly its fossil fuel resources – at an unprecedented rate, damaging the atmosphere in the process.

If the rich, industrialised countries want to limit average global temperatures, they will have to commit to zero carbon emissions, whilst working vigorously to restore the earth's capacity to absorb greenhouse gases. The previous suggestions by the EU of an 80% reduction in CO2 emissions by 2050 are woefully inadequate and some scientists regard it as irresponsible given the gravity of the current situation. In Bali, the rich countries have used all the timidity at their command to propose such inadequate target figures. We have already reached the stage of dangerous climate change: the task now is to prevent catastrophic climate chaos.

"Climate justice" means giving the poorer countries access to renewable energy technologies to help them with truly sustainable development. Only if we can show the plausibility and benefits of development without fossil fuels can we encourage third world countries to initiate their own emissions reductions.

Second, governments need to make every effort to protect the world's ecosystems, like forests and coral reefs. Large-scale projects to reforest denuded areas of land are also needed, above all else for the benefit of local populations. We must begin to pay developing countries for the global "ecosystem services" provided by their forest cover – and their capacity to absorb carbon dioxide and to release moisture to distant places.

Affirming the principle of "ecological debt," we need to acknowledge that victims of climate change are entitled to have their ecosystems restored, to have the loss of land and livelihood they have suffered properly addressed – and to establish legal precedents to that effect.

Above all, we must seize this moment of public awareness to force politicians to do the right thing. We should be clear: politicians will not make the right choices with respect to climate and development unless they are forced by public pressure to do so.

It is my hope and the hope of millions of people in this country and throughout the world that the next President of the United Stated will embark on a Renewable Energy Revolution. The United State needs a new kind of leader; a leader who will not shy away from making hard choices. It is often said that people are green in principle, but cynical in practice. It will take a strategy of action and tremendous public education and motivation to change this. But if we are committed to saving the world from climate change catastrophe, we must act now.

The World Future Council, as the voice of future generations, is drawing special attention to the importance of renewable energy as the basis of a totally new energy system for the planet. We need to initiate appropriate policy in this country and worldwide to install carbon-free, decentralized, efficient, renewable and secure energy systems sufficient for all the earth's people. This switch needs to start immediately. The World Future Council perceives it as a crime against the future if the gap between 'knowing' and 'acting' in all the related areas of climate change is not overcome immediately.

It is the responsibility of leaders everywhere to fully understand this problem if they are to meet the challenges before us. Failure to act effectively is likely to precipitate cataclysmic changes in the earth system that could obliterate life on earth.

The CHAIRMAN. Great. Thank you, Ms. Jagger, very much.

And our final witness is Mr. Tom Buis, who is the President of the National Farmers Union. Welcome, sir.

STATEMENT OF TOM BUIS, PRESIDENT, NATIONAL FARMERS UNION

Mr. BUIS. Thank you, Mr. Chairman and members of the committee. I am President of the National Farmers Union. We're 106 years old and represent a quarter million family farms and ranches around the country.

We're here to say to you, Mr. Chairman, and the members of the committee that rural America is ready, willing and able to do its part to help our nation solve probably our biggest economic, national security and environment challenge that we've ever faced. We have some experience in renewable energy over the past three decades after the first oil embargo in the early '70s. A lot of people started talking about renewable energy and what we could do.

We started out with a product called "gasohol." It wasn't very efficient both economically or energy-wise, but it took about 30 years worth of investment in technology in the industry, mostly by farmers, mostly by local people. And we really didn't cross that threshold until the Federal Government stepped in with a renewable fuel standard, with a mandate which gave us certainty for a marketplace.

We would hope that the same would happen in all types of renewable energy. We think a renewable portfolio standard is past due. Last year, we did a study on the potential benefits to rural America and our nation if you adopted a 20 percent renewable portfolio standard for renewable electricity generation. And the production of electricity from wind alone would result in about a half a billion dollars in payments to farmers in leases. Production electricity from renewable biomass would result in about $25 billion to farmers growing these new crops, and $43.5 to $66 billion in capital would be invested in these new clean energy facilities in rural America.

The types of projects developed also play a critical role. A NREL study compared the benefits of local ownership versus outside ownership and found that locally owned wind projects generate 2.5 times more jobs and 3.1 times more rural economic benefits than those with outside ownership. Our policy strongly encourages that any federal policies should provide incentives and foster the development of locally owned projects.

Unfortunately, tapping rural America's clean energy potential is not likely to occur without the support of governmental policies. Community-based wind energy projects face additional hurdles because of limited capital access. It's becoming increasingly difficult to produce wind generators and associated equipment for community wind projects due to the size of those projects and a shift towards large-scale development processes, not just in the cost but also in the infrastructure and access to the grid.

Moreover, because the PTC can only be used against passive income, many community-based projects are not able to fully utilize this provision. Most interested parties in these community projects are farmers and local citizens that own the land with the potential

for wind development yet do not have sufficient levels of passive income necessary to utilize the tax break. We believe it is critical for the federal policy to continue to foster the development of renewable electricity projects. We support the extension of the PTC. We would hope that it would be a longer term so we would get the market certainty and investment in the technology that's necessary.

Thank you, Mr. Chairman. I would be glad to answer any questions.

[The prepared statement of Mr. Tom Buis follows:]

STATEMENT OF TOM BUIS, PRESIDENT
NATIONAL FARMERS UNION

BEFORE THE U.S. HOUSE OF REPRESENTATIVES SELECT COMMITTEE ON ENERGY INDEPENDENCE AND GLOBAL WARMING

CONCERNING: THE RENEWABLE ENERGY ECONOMY: A NEW PATH TO INVESTMENT, JOBS AND GROWTH

MARCH 6, 2008

Good afternoon, Mr. Chairman and members of the committee. I appreciate the opportunity to testify on behalf of the farm, ranch, and rural members of National Farmers Union (NFU). Our policy is created, revised and updated each year at the local, state and national levels, and formally adopted at our annual convention, which concluded two days ago.

Rural America has the unprecedented ability to provide significant amounts of clean, renewable energy including ethanol, biodiesel, and renewable electricity for our nation. Not only does fostering the development of renewable energy move us toward energy independence, it also provides a critical source for rural economic development that is and will continue to significantly jump-start rural economies.

We are already seeing results thanks in part to congressional efforts to enact and expand the Renewable Fuels Standard (RFS). The ethanol industry has grown from a 900 million gallon industry in 1990 to an industry with 143 ethanol bio-refineries in 26 states with a capcity of 8.16 billion gallons of production. In addition, 57 new plants are under construction and seven others are currently under expansion which will add another 5.25 million gallons of annual capacity. Today, ethanol is blended in 50 percent of the nation's gasoline and will soon be blended in 100 percent.

A recent study by LECG, found that in 2007 the ethanol industry added $47.6 billion to the nation's Gross Domestic Product (GDP), created nearly 240,000 new jobs in all sectors of the economy, and added $12.3 billion to American consumers' incomes.

These overall numbers only tell part of the story. Not only is the expansion of the ethanol industry helping wean ourselves from foreign oil while benefitting the overall economy, it is having a profound impact on rural economies throughout the nation.

Farmers are receiving a fair return for their commodities by the creation of competition within the marketplace. After years of low prices and reliance on critical farm safety net programs, farmers are now receiving their income from the marketplace. Studies have shown the local price of corn increases by a minimum of $0.05 to $0.10 cents per bushel in the area around an ethanol plant. U.S. farmers sold 2.4 billion bushels of corn to ethanol bio-refineries in 2007 valued at $8.1 billion. That said, farmers produced 10 percent more corn than was needed for all purposes in 2007; with the extra supply being carried over into 2008.

Farmers are not only benefiting from higher prices, but also from local ownership of ethanol production facilities. Farmers and other local investors own 40 percent of the nation's ethanol production. Taken together, these locally owned plants represent the single largest producer of ethanol in the country. While

concentration of ownership has increased in every other segment of the agricultural sector, the market share of the four largest ethanol companies has declined from 73 percent in 1999 to 31.5 percent in 2007.

In short, economic opportunities are returning to rural America. A 50 million gallon ethanol plant increases a local community's GDP by $152.3 million; increases househould income by $40 million; increases local spending by $56 million; and creates more than 600 new jobs.

NFU believes the success of today's ethanol industry is simply the starting point for producing renewable energy in rural America. We applaud congressional efforts to significantly increase and expand the RFS to speed development of cellulosic ethanol and biodiesel.

We believe it is equally critical for the federal government to help spur the development of the renewable electricity industry and applaud the House of Representatives attempts to enact a Renewable Portfolio Standard (RPS) and extend the renewable energy Production Tax Credit (PTC) during consideration of the Energy Independence and Security Act of 2007. Further, we appreciate efforts to extend the PTC in the Renewable Energy and Energy Conservation Act of 2008, which was approved by the House last week.

Renewable electricity generation from rural America is a largely untapped resource. Study after study indicates that rural America has the potential to supply significant percentages of the United States' energy needs within the next two decades. The U.S. Departments of Agriculture and Energy have found that the United States has the capacity to produce nine billion tons of biomass from farmlands by 2030, which could be used for both electricity generation and cellulosic ethanol production.

Last July, NFU released a report on the economic benefits rural America would realize if 20 percent of electricity consumed in the United States came from renewable sources. Production of electricity from wind would result in rural landowners receiving between $475 million and $562 million in payments from wind farm leases. Production of electricity from renewable biomass would result in payments of at least $25 billion to farmers of these new crops; and $43.4 to $66.7 billion in capital would be invested in new clean energy facilities mostly in rural areas.

The type of projects developed also play a critical role in the resulting benefit to rural America. A National Renewable Energy Laboratory (NREL) study compared the benefits of local ownership versus outside ownership and found that locally-owned wind projects generate 2.6 times more jobs and 3.1 times more rural economic benefit than those with outside ownership. Echoing this point, a 2006 study by Oregon State University concluded that local ownership of wind turbines would result in five times the annual projected income versus entering into a land lease agreement. Given this fact, NFU believes federal policies should foster the development of locally-owned projects.

Unfortunately, fully tapping rural America's clean energy potential is not likely to occur without the support of governmental policies. Renewable electricity technologies face many barriers when competing in today's marketplace. While they can stabilize and even reduce long-term energy costs, renewable electricty projects generally have high upfront capital costs and longer payback periods. In some cases, utilities have used their market power to block new renewable energy competitors from entering the market. Renewable energy resources also lack the developed infrastructure of other energy industries which have enjoyed decades of government support.

Community-based wind energy projects face additional hurdles, which are typically smaller in scope than commercial lease-based models because limited capital access. It has become increasingly difficult to procure wind generators and associated equipment for community wind projects due to the size of community based projects and the shift toward large-scale development processes.

Most community wind projects are planned based on available capital and resources provided by community members. In contrast, most commercial scale projects are planned around the economic returns measured by scale; limited access to capital is a secondary consideration. Therefore, most community wind projects are at a competitive disadvantage when attempting to use limited capital investment to develop a site, hire qualified consultants, and procure turbines, towers and rotor blades.

Minimum order requirements for major components are larger than what community wind projects need. As a result, community based projects most often attempt to coordinate procurement efforts with larger developers. This coordination does not guarantee the community wind project the needed components in a timely fashion.

Further, order deposits for equipment are cost-prohibitive for community projects. Most manufacturers require a 25 percent deposit upon placement of the order which must be placed with 18 to 20 month lead time due to the demand placed upon the manufacturers. With turbine costs at nearly $1.6 to $1.8 million per unit, most community wind projects do not have the capital to invest in equipment deposits for the required lead time.

Moreover, because the PTC can only be used against passive income, many community based projects are not able to fully utilize the PTC. This is because most interested parties are active farmers and ranchers that own land with potential for wind development yet do not have sufficient levels of passive income necessary to utilize the full PTC. As a result, many potential projects with excellent wind potential are at an economic disadvantage and are unable to compete for Power Purchase Agreements with projects that can fully utilize the PTC.

NFU believes it is critical for federal policy to foster the development of renewable electricity projects and in particular locally-owned community-based projects.

As I have already mentioned, we applaud the House of Representatives' efforts to extend the renewable energy PTC, which provides a two cent/kilowatt-hour credit for electricity produced from renewable sources such as wind. The PTC is set to expire on December 31, 2008. Under current law, the PTC provides the most important federal incentive to continue development of wind projects. Failure to extend it will have significant impact on development. The PTC has unfortunately lapsed on three occasions in the past -- 1999, 2001, and 2003. Each time investment dollars stopped flowing into projects, jobs were lost and the growth of the industry declined. Industry experts indicate a significant decrease in development of new projects will occur before summer if the production tax credit is not extended soon.

We also support expansion of the Clean Renewable Energy Bonds "CREBs" program which is essential to quickly expanding projects in rural America.

NFU believes one of the surest ways to jump-start the renewable electricity marketplace is through enactment of a federal RPS which requires a certain percentage of the market be supplied by new renewable energy. The success of the RFS in spurring the development of the ethanol industry illustrates what a RPS could do for the renewable electricity sector.

NFU supports a RPS that ensures 25 percent of our energy usage comes from renewable sources by 2025 that also includes incentives for local ownership. Ensuring a predictable, steadily growing market will encourage investors to build the manufacturing capability and infrastructure needed to reduce the price of renewable electricity technologies that will help make locally owned wind projects more competitive.

America's family farmers and ranchers are playing a significant role in reducing our nation's dependence on foreign oil by producing fuels from the farm, such as ethanol, and these efforts are revitalizing rural communities across the country. Further developing our wind and bioenergy resources through a RPS would produce a similar, positive outcome for the countryside.

Thank you again Mr. Chairman for the opportunity to testify. I would be happy to answer any questions from committee members.

The CHAIRMAN. Great. Thank you very much. All time for statements by the witnesses has expired, so now we'll turn to the question and answer period. The chair will recognize himself.

Mr. Abate, you said how many new megawatts were installed for wind in 2007?

Mr. ABATE. In the United States, 5,244.

The CHAIRMAN. Five thousand, two hundred and forty-four. And that represented 30 percent of all new electricity installed in the country last year?

Mr. ABATE. All new nameplate capacity 30 percent, correct. Second to only natural gas.

The CHAIRMAN. Natural gas what was percent?

Mr. ABATE. It was first—I believe it was about half.

The CHAIRMAN. About 50 percent?

Mr. ABATE. Yes.

The CHAIRMAN. And I think it was about 10 percent was coal?

Mr. ABATE. Yes.

The CHAIRMAN. And the rest came from all other sources. So what would you predict would happen in 2008, this year, if the production tax credit is extended?

Mr. ABATE. Well, in—that's a good question. And when you look at our view, we can see the next couple of years. The market is long on turbines right now with the full confidence that the production tax credit will be extended. The pro formas for these investors all have that in them. So in 2008, our production capacity, if you take what that's scaling to and doubling it, it will be between 7 and 8 gigawatts.

The CHAIRMAN. Seven and eight thousand new megawatts?

Mr. ABATE. Yes.

The CHAIRMAN. On top of only 5,200 this year?

Mr. ABATE. Right.

The CHAIRMAN. So what would it project out to then for 2009? In other words, what's the projection in terms of new wind power?

Mr. ABATE. If you just take our order book and what we're seeing as far as demand in the market, with a stable policy, by 2010, this country could be well over 10 gigawatts.

The CHAIRMAN. Ten thousand megawatts every year being produced?

Mr. ABATE. Yes.

The CHAIRMAN. And how many new nuclear power megawatts will come online this year in the United States, do you know?

Mr. ABATE. None.

The CHAIRMAN. How many next year, do you know?

Mr. ABATE. The same.

The CHAIRMAN. How many in 2010, do you know?

Mr. ABATE. For some time it'll be zero.

The CHAIRMAN. Zero.

Mr. ABATE. And the reason is capacity, to be able to pull that off and the investment and the long-term cycle of that technology.

The CHAIRMAN. So in other words, if there's 10,000 new megawatts every year for 2010, 11, 12, 13, 14, 15, and it could actually get larger, huh? So there could be 100,000 new megawatts of wind installed in the United States before the first 1,000 megawatts of nuclear power comes online?

Mr. ABATE. That's a reasonable assessment, yes.

The CHAIRMAN. Mr. Unger, do you think that's a reasonable assessment?

Mr. UNGER. You know, the market——

The CHAIRMAN. Could you move in and turn on the microphone, please?

Mr. UNGER [continuing]. Sorry. I think the market will speak to that. One of the things that I look at is who is going to finance these projects? Public markets, investment bankers and the like are very willing to fund wind projects, very willing to fund geothermal projects, willing to find biomass projects. It doesn't appear to be an appetite today to fund nuclear projects. The French are building I think the most advanced nuclear technology plant in the world today. It's $2 billion and it's already years behind schedule. So it's quite a bit of uncertainty in the construction cost before they can even come online, and the generating costs, which are higher than that of wind, certainly don't include what we do with the waste. So it creates uncertainty which investors are unhappy about.

And as he says, if we have certainty about tax credits, then we have certainty about tying up our money. Venture capitalists tie up their money for ten years. And we'd like to have that kind of certainty.

The CHAIRMAN. So you're saying that you agree with Mr. Abate's projection for how rapidly this is going to increase in the wind sector?

Mr. UNGER. Oh, completely. Completely.

The CHAIRMAN. Or is he even being conservative?

Mr. UNGER. He may be being conservative. The nice thing about wind and solar is that, you know, we were having this conversation before—some states are blessed with a lot of sun. Some are blessed with a lot of wind. You can scale these plants. But the kind of commercial plants we're talking about here are very, very large. But in rural America where there's, you know, fewer access to generation lines and the like, you can also have smaller plants like this, which create a lot of local jobs around local economies. It's very difficult to do that with very large coal-fired or nuclear-fired plants.

The CHAIRMAN. And Ms. Lockwood, what do you think is the potential in Arizona for solar power by 2015? How many megawatts do you think you can be producing?

Ms. LOCKWOOD. Mr. Chairman, I believe with a long-term extension of the ITC, you could see well over 1,000 megawatts of large-scale solar built in Arizona alone by 2015, probably even more than that.

The CHAIRMAN. Probably even more than that?

Ms. LOCKWOOD. Mm-hmm.

The CHAIRMAN. And, again, this is all before the first nuclear power plant comes online after 25 years. So that's pretty big news in terms of what is happening out in the marketplace with an extension of the production tax credit for renewable energy.

And at this point my time has expired. I'll turn and recognize the gentleman from Wisconsin.

Mr. SENSENBRENNER. Thank you very much, Mr. Chairman. We've been on kind of a perpetual debate on tax credit extenders.

The Ways and Means Committee doesn't want to make any of these things permanent, which I believe is a mistake. But that frankly is the way it is.

We may end up getting to the business of prioritizing tax extenders to get something through the Senate. I'd like to ask each of you that's kind of in the business which two tax extenders would you prioritize as being the top two? And I would throw in the R&D tax credit as well in terms of incentivizing new technologies, so put that on the table. So let's start with you, Mr. Abate.

Mr. ABATE. Yeah. I think full value production tax credit would be number one for as long as that can work and get it through. And as I had said, because of the pro formas that our customers have counted on, that's what's in their model. So anything different than that would be a disruption, in our view.

Second is investment tax credit for some of the large capital projects. You know, wind is more of a production-based. The investment tax credit would be number two.

Mr. SENSENBRENNER. Okay. Mr. Swezey.

Mr. SWEZEY. Congressman, I'll go back to your original statement that I believe sincerely that we need a diverse portfolio of energy resources.

Mr. SENSENBRENNER. I'm asking for priorities. I know you want it all. We might not be able to give it to all.

Mr. SWEZEY. From my company's perspective, we're very interested in extension of the solar credit, long-term extension to give security to the predictability——

Mr. SENSENBRENNER. And what's number two?

Mr. SWEZEY [continuing]. And we're very interested in the R&D tax credit as well, because we have——

Mr. SENSENBRENNER. Okay. Mr. Unger.

Mr. SWEZEY [continuing]. A very large R&D function at our company.

Mr. SENSENBRENNER. Mr. Unger.

Mr. UNGER. I think we would be looking for tax credits that would not select one industry over the other. We are specifically looking for a playing field that will allow a variety of solutions to compete.

Mr. SENSENBRENNER. Okay. Number one and number two.

Mr. UNGER. So if any of the tax credits exclude others, then I think we're trying to play economic policy. So R&D across the board would be good. You know, production tax credits across all technologies, not to consider one technology over the other.

Mr. SENSENBRENNER. Okay. Thank you. Ms. Lockwood.

Ms. LOCKWOOD. Congressman Sensenbrenner, our first priority would be long-term extension of the investment tax credit because of our solar resource in Arizona. Number two would be the production tax credit.

Mr. SENSENBRENNER. Okay. Ms. Jagger.

Ms. JAGGER. Congressman, I think that—I would like to talk about a proposal that was made yesterday.

Mr. SENSENBRENNER. I'm asking which tax credits were the top two priorities.

Ms. JAGGER. Well, I think an all-across technology tax credit, but I will support as well the fitting in tariff that was introduced yesterday by Congressman Jay Inslee.

Mr. SENSENBRENNER. Okay. Mr. Buis.

Mr. BUIS. Production tax credit. The PTC and also the VTECH, which helps the ethanol and biodiesel.

Mr. SENSENBRENNER. Okay. Thank you very much. I yield back the balance of my time.

The CHAIRMAN. The gentleman's time has expired. The chair recognizes the gentlelady from South Dakota, Ms. Herseth Sandlin.

Ms. HERSETH SANDLIN. Thank you, Mr. Chairman. Mr. Buis, thank you for your testimony today and the study that the National Farmers Union has done. Chairman Markey and I have discussed the issue of the transmission capacity in getting these wind resources out of the Great Plains and other parts of the country, and we know how important that will be to fully maximize the benefits that the wind energy and the solar energy in certain areas across rural America have.

But I entirely agree with you as well about the importance of the local ownership and the local use of wind energy rather than just exporting these renewable sources out of the states that have the most abundant source. So you have stated in a number of areas in your testimony the importance of that local investment, the importance of altering the PTC to serve as an incentive for that local ownership and investment and development community-based wind energy, the community-based energy development like we've seen in Minnesota.

Could you talk in just a little bit greater terms about where we need to make changes in federal policy as well as working with our counterparts in the state legislatures, whether that's with net metering or other options available to assist farmers and ranchers and rural families not just in the lease payments they get for turbines on their land owned by larger wind farms and selling those to larger utilities, but how we can do more to benefit those rural economies based on some of the statistics you gave in job creation?

Mr. BUIS. Thank you, Congresswoman Herseth. I think you captured a lot of what's really going on in rural America. Every farmer, every rancher, every local person I've met in the past two years are so excited about the opportunity to help develop energy, not just ethanol, not just biodiesel, but wind and solar. And we have these obstacles.

The state of Minnesota, as you referred to, has a community-based requirement for any renewable energy developed in that state. Ten percent has to be community owned. And that's to carve out some local ownership, you know. We've seen in the past in the production of farm commodities when that ownership goes away, the money follows. It's taken out of those communities. It's not reinvested in those communities. And the beauty about ethanol has been its been local ownership. The single largest owners and producers of ethanol today are not the big multinational grain companies. It's farmers and local communities. They own 40 percent of the ethanol production. That gets reinvested in the community. You see boards coming off the storefronts instead of going up.

If we allow this, whether it's ethanol or wind or solar, to all be taken out of that local control where they're just paying for a footprint on a wind tower, I think we'll lose those jobs, we'll lose those benefits and we'll lose a tremendous opportunity.

Ms. HERSETH SANDLIN. Thank you. And then the only other point I would make is the further work that we'll do with you and, Chairman Markey, if we can pursue this, the issue of the PTC, how it's structured because it's currently only against the passive income.

The CHAIRMAN. Absolutely.

Ms. HERSETH SANDLIN. Okay. Thank you. And thank you, Mr. Chairman.

The CHAIRMAN. Thank you. The gentlelady's time has expired. The chair recognizes the gentleman from California, Mr. McNerney.

Mr. MCNERNEY. Thank you, Mr. Chairman. And as many of you know, I spent two decades of my career in the wind industry business, and I understand exactly how the production tax credit affects the industry and how the cyclical pattern has put us way behind the Europeans and other parts of the world.

Mr. Unger, I have a question. What percentage of your production of new machines is being sold to overseas customers? Mr. Unger.

Mr. ABATE. Mr. Abate you said or Unger?

Mr. MCNERNEY. I'm sorry. Mr. Abate.

Mr. ABATE. Oh. About 30 percent.

Mr. MCNERNEY. And what percentage of those are produced overseas, of the 30 percent?

Mr. ABATE. Those are produced overseas.

Mr. MCNERNEY. So it's fair to say that in our opinion, if we extend the production tax credit, many more jobs will be created in the United States?

Mr. ABATE. Oh, yeah. Seventy percent are landing here in the United States, and a big part is, I think as you have a production tax credit here, more components, more machines will land here. If that changes, our customers who land these pieces of equipment are looking to go to other parts of the world.

Mr. MCNERNEY. So if you sell machines here, you both produce them here and you create jobs in the field with maintenance and installation?

Mr. ABATE. Right.

Mr. MCNERNEY. Most of the work that goes into producing a windmill, is that all work produced here in the United States, or do you import products from overseas?

Mr. ABATE. No. The assembly occurs here. Components we do source globally. But a lot of the components, due to their size, blades will be here, towers will be here. You know, components, electronic components can be global. But logistics make up about 20 percent of the cost of a wind project. So it really forces that technology to be local relative to where the equipment is going to land.

Mr. MCNERNEY. Thank you. And, Mr. Swezey, I think it was very illustrative that all of your production is being sold overseas now. And that's a terrific loss for the United States of America.

How can we incentivize customers here to start buying your products and then selling them here in our country?

Mr. SWEZEY. Right. All our customers for our thin film solar equipment line are overseas, and that has to do, as I explained both in terms of the incentives for locating production but also the end-use market. The panels that our technology produces are five point square meter panels. I mean, they're based on flat panel display technology on glass. These are very large panels, and it makes sense to try to locate these production facilities near the end-use load. And we believe that if we do have a clear, consistent, long-term policy towards solar in the U.S. that we'll see more—some of this manufacturing occurring in the U.S. for that reason, because it will build the market.

The U.S. market today is only 10 percent of the entire global photovoltaic industry, yet we generate 25 percent of the global electricity. So there's a disconnect there between how much we're doing here in solar and what the rest of the world is doing.

Mr. MCNERNEY. Thank you. Ms. Jagger, what steps of European governments are most effective in your opinion in developing new energy technologies and implementing that?

Ms. JAGGER. I think that until now, the most effective has been Germany, and the Feed-In tariff that was introduced by the member of Parliament, Mr. Hermann Scheer. I think that had the most effect and they have been able to produce about 200,000, between 200,000 and 250,000 jobs.

So that's what I was talking about with Congressman Jay Inslee together with the organization that I chair, yesterday, introduce the tariff legislation or policy in this country, and it will be really important that his policy be supported. I think it will make a big difference for this country. There are about 40 countries that have already, you know, embarked or embraced the Feed-In tariffs around the world.

Mr. MCNERNEY. Okay. Thank you. And I reserve——

The CHAIRMAN. The gentleman's time has expired. We appreciate that. We have a series of roll calls on the floor, and we're trying to ensure that each member who is here gets a chance to ask some questions. Mr. Engel is here as a special guest of the Select Committee. We'll recognize him for the purpose of asking questions.

Mr. ENGEL. Thank you, Mr. Chairman. It's good to be a special guest. Ms. Jagger, in your testimony, you said—I was struck by your remarks that you used to believe that reduced energy consumption was an important first step, and you used to believe that it would be enough to encourage more localized lifestyles, but you now say you realize that that's not enough.

I also have come to that conclusion, as have many Members of Congress, and I think it's important to keep saying. I'm embarrassed that our country has not agreed to sign international agreements that would help with global warming. But countries like India and China, who have been exempted from these things, I really believe that if there are new international agreements that countries like India and China, which are now becoming more responsible for global warming, need to be included in these agreements as well. Would you agree?

Ms. JAGGER. What I will say, Congressman, is that it is vital that the United States realize that they need to sign onto the Kyoto Plus treaty. It is vital as well that the industrialized nations of the world realize that they need to come up with a reduction of CO_2 emission that is realistic and not just simply what they think they can do, because otherwise, we will not be able to avert a climate change catastrophe.

With regard to India and China, I think that it is very important that we supply and that we help them with providing renewable energy technology. What is important as well to understand for certain countries is that we cannot make them accountable for what we in the developed world have been responsible. Therefore, we have to keep that in mind, that it will be totally unfair if tomorrow we ask from China, India or Brazil to come up and sign the exact kind of agreement that would be required from the United States or from a European country.

Mr. ENGEL. How about Brazil? Since you mentioned Brazil, I noticed in your testimony, you know, you said that ethanol and nuclear are not a solution. Yet I was just in Brazil and was amazed at the amount of—how much ahead they are of this country in terms of planning for the future and looking at alternative energy and weaning their country away from gasoline and things like that. Do you think we could learn something from Brazil?

Ms. JAGGER. Well, there are certain polices that have been implemented in Brazil that I will question. I mean, I think that we have to realize that the use of biofuels and bioethanol, some of those technologies can lead us to have a humanitarian catastrophe, because we will be using farm land that should be used for feeding people rather than for—be used as fuel.

I mean, one thing that I'd like to mention is that 200 times more surface area is required to produce energy from crops as compared with energy from photovoltaic cells.

Mr. ENGEL. Thank you. I know, Mr. Chairman, we have votes, so I'll end my questioning and I thank you for letting me participate.

The CHAIRMAN. I don't want the gentleman to miss the roll call. There's now under one minute left to go, to go approximately a quarter of a mile to make the roll call on the House floor.

Mr. ENGEL. Well, it's good exercise. It'll contribute to—against global warning I guess, you know, if we walk on our own and don't ride.

The CHAIRMAN. Let's walk that walk then because we will miss the roll calls otherwise. But I think that it's pretty clear from the panel today that the extension of the production tax credits, the incentive to this industry is going to result by 2015 in 100,000 megawatts of renewable energy, electricity in our country, minimum.

And by the way, there's only 100,000 megawatts of nuclear power in the United States today after 50 years of federal subsidies. So no one should be embarrassed about the fact that we are going to give a relatively modest break to the competition to nuclear and other energy resources.

I think rural America is ready to go. We have to solve the transmission issues. If we get the tax issues right, then we can have a

clean energy revolution that produces 15, 20, 25 percent of the electricity in our country and sends a signal to the rest of the world that we are serious.

We thank all of you. You're great leaders. With that, this hearing is adjourned. Thank you.

[Whereupon, at 10:55 a.m., the select committee was adjourned.]

**Response of Victor Abate, GE Energy
to Additional Questions of
Members of the
House Select Committee on Energy Independence and Global Warming
following the hearing on "The Renewable Energy Economy: A New Path to Investment, Jobs, and Growth"**

In addition to our specific responses below, we would also like to call the Committee's attention to the DOE's recently-released "20% Wind Energy by 2030" report, located at http://www.eere.energy.gov/windandhydro/pdfs/41869.pdf

1) **How many solar panels and wind turbines would be needed say to meet a 1% renewable standard worldwide? How would this shift your business model and what areas would you shift your production from to meet this demand?**

   Renewable energy currently accounts for 5 percent of global power capacity and 3.4 percent of global power generation (excluding large hydro). To achieve a 1% incremental increase in renewable electricity worldwide (i.e. shifting 35 GW of the current global installed base of 3,500 GW to renewables) we estimate that 40,000 wind turbines and 500,000,000 solar panels would be needed. The impact on production would depend both on relative regional growth and on manufacturing and transportation costs. We currently and will continue to have a global supply chain, with manufacturing in the United States, Europe, and Asia. If US solar and wind policy were to become more long-term and predictable, the US could develop an export base like that of Germany and other European countries that have become wind technology exporters.

2) **Would you agree that current renewable energy is just a small portion of what needs to be done in energy to lower carbon emissions?**

We believe that renewable energy will be one of the significant "wedges" needed to achieve long-term carbon emission reductions. Other potential wedges include energy efficiency, fuel switching in power generation (coal to natural gas), fuel switching in transportation, carbon capture, and nuclear power. The strategy of our Power Generation business reflects this portfolio approach. The advantages of renewable energy over other low/zero-carbon options (such as natural gas, carbon capture, and nuclear power) include a zero fuel cost, the ability to act as a fuel price hedge, and a short lead time.

3) Could you highlight some of the work that GE is doing in areas such as energy efficiency? Nuclear? And carbon capture systems?

GE, through its businesses and network of Global Research Centers, is investing heavily in energy efficiency through ecomagination, a company-wide commitment to deliver environmental solutions for our customers. This commitment has three parts:

- Double annual revenue from ecomagination products to $25B by 2010 (goal increased from $20B in 2008)
  - Ecomagination products accounted for $14B in revenue in 2007
  - 62 products certified by March; goal of 70 products by year-end
  - Products emphasizing energy efficiency include aircraft engines, compact fluorescent lighting, locomotives, and advanced gas turbines
- Reduce company greenhouse gas emissions through 1-30-30 goal
  - Reduce absolute emissions by 1% from 2004-12
  - Reduce emissions intensity by 30% from 2004-08
  - Improve energy efficiency by 30% from 2004-12
- Keep the public informed through annual reports and announcements.

GE is also developing nuclear power as a baseload zero emission technology, including an alliance with Hitachi created in 2007 to serve the global industry.

GE's nuclear business develops advanced light water reactors and provides a wide array of technology-based products and services to help owners of both boiling and pressurized water reactors safely operate their facilities with greater efficiency and output.

GE's "clean coal" IGCC (Integrated Gasification Combined Cycle) technology is aimed at reducing emissions by 50 percent relative to conventional coal power plant. GE is working on carbon capture technologies with customers, using the experience of our oil and gas business with gas sequestration to improve well production. Our standard reference plant designs for IGCC include configurations with the potential for carbon capture and sequestration.

4) Can you tell us more about the marine energy that GE is pursuing in Scotland?

In 2006 GE announced it would provide capital (debt and equity) to Ocean Power Delivery (renamed Pelamis Wave Power in 2007), a Scottish company developing the world's first commercial facility to generate electricity from offshore ocean waves. The technology generates 750 kW of electricity from offshore wave motion. The company is currently pursuing projects off the coasts of Scotland, Cornwall (UK), and Portugal.

5) If the U.S. passed cap-and-trade legislation, how would the price of inputs vary? (particularly the metal that is used in the production of solar panels and wind turbines) How would this price difference affect the final price of your products?

Cap-and-trade legislation could result in higher prices of inputs for wind turbines as component manufacturers pass through the cost of carbon. However, wind turbine manufacturers could seek to mitigate this possible impact by managing, as they already do, material cost escalation through technology and productivity improvements. More importantly, this impact is expected to be less than the cost-of-electricity increase in conventional fossil

electricity projected to result from a carbon price, thereby improving wind's competitiveness.

6) **Can you talk a little bit about offshore wind energy production? What is the potential for offshore turbines? What is the size and generating capacity compared to land-based turbines? What can be done to increase the possibility of new offshore-wind production?**

The magnitude of the offshore wind resource suggests a considerable long-term potential. However, offshore wind accounted for only 1% of global wind capacity (1 GW of 100 GW) at the end of 2007 and is projected to account for less than 5% of new wind installed capacity from 2008-2015. To scale up more quickly, offshore wind must solve technology, supply chain, and policy challenges.

GE has first-hand experience with offshore wind technology, having co-developed and supplied turbines for the Arklow offshore project. The Arklow project consists of 7 turbines, each with a rated power of 3.6 megawatts, and is located 10 miles off the Irish coast. The Arklow project has accumulated over 20,000 hours of operating experience and has provided important lessons regarding the novel challenges of moving a wind project offshore in areas such as environment, health and safety, construction, and operation and maintenance. Arklow has also highlighted the need to reduce offshore wind's cost of electricity and improve reliability; development of a "next generation" offshore technology is an area of GE's ongoing wind R&D investment.

Second, offshore wind must draw on a supply chain that is focused on ramping up capacity to meeting explosive demand for onshore wind components. Offshore wind components require longer lead times than their onshore counterparts. In addition, a growing offshore wind industry faces potential new bottlenecks such as a shortage of installation vessels.

Finally, offshore wind policy has yet to create a steady, long-term demand that would justify the investments in capacity expansion needed to achieve economies of scale and bring down the costs of this immature technology. With the exception of a handful of European countries, current incentive levels have made it difficult to make offshore project economics work for technology providers, developers, and utility customers.

7) **What sort of wind resources are available throughout the country? What regions have the greatest wind resources and which regions have the greatest potential to effectively utilize wind power?**

As mapping by the National Renewable Energy Laboratory indicates, the wind resource in the United States is abundant and geographically diverse. The theoretical potential is estimated to be sufficient to meet current US electricity demand three times over. The strongest resource exists in the interior West, but with the exception of the Southeast, many regions have resources characterized as "good" or better.

8) **On page six of your testimony, you estimate that the expiration of the current wind production tax credit would lead to a 90% drop in wind power installations. Do you mean a 90% drop in the construction of new installations or that 90% of existing wind operating plants would shut down?**

Our testimony cites a study estimating that the tax credit expiration would result in a 90% reduction in wind power installations in 2009, compared to expected installations in 2008. This estimate refers to new installations and not to existing plants.

9) **In your testimony, you say that technological advances have helped wind energy grow and become more reliable –What research or development strategy should we**

take on the federal level to help encourage such technological advances in the future?

Continued technology advancement requires a combination of fundamental research, technology development that is higher risk/higher impact, and evolutionary technology advancement.

- Fundamental research - typically performed by universities and national labs. Advances in the basic engineering understanding of materials, aerodynamics, etc. are the building blocks for the industry to make continued technological progress. DOE is an important source of funding for this type of work.
- Higher-risk/higher-impact technology advancement - typically combines the fundamental research with product component expertise, resulting in new applications. Because of the higher risk, cost-share partnerships between private industry and DOE are critical in enabling these technologies to be developed and tested to a point where private industry can complete the implementation of the technology in commercial products.
- Evolutionary technology advancement - the day-to-day improvement that private industry makes in product development, using technologies that have been validated and are ready for commercial use. This is the responsibility of industry and does not require federal support.

GE recommends a federal R&D strategy that supports fundamental research and higher-risk/higher-payback technology development through the Department of Energy's Wind programs. The DOE Wind budget is smaller than that for other renewable technologies. With its available funding, the DOE has focused on very important *non-turbine application* activities (such as grid integration) that are required to pave the way for the Department's 20%/2030 wind penetration goal. However, DOE does not have sufficient funds to also work the recommended *turbine-specific technology* areas (which span both the fundamental research and technology advancement areas described above). GE therefore supports the

American Wind Energy Association (AWEA) call for a doubling of the DOE Wind budget, which would allow DOE to cover both non-turbine application and turbine-specific technology activities.

10) What kind of grid integration technologies can help wind power behave like conventional power plants? Would this mean that they could become solid baseload providers? How far off is that technology?

Baseload power generation equipment is continuously generating power with relative constant output. Wind power is inherently an intermittent power source due to its dependence on the variable wind resource. Wind power would have to be combined with some type of energy storage to provide reliable baseload power. Various concepts including pump storage systems and battery energy storage systems have been identified, but these currently cannot compete with conventional baseload plants (e.g. nuclear plants) in terms of cost or reliability.

From an economics perspective, a combination of a wind plant with conventional peak load power generation equipment, such as gas turbines, appears to be more attractive. However, peak load power generation equipment requires at least 15 - 30 minutes before the generation capacity becomes available to the grid. Wind forecasting techniques and special wind plant controls are being developed, but additional low-cost, utility-scale energy storage systems would still be needed to provide reliable baseload generation under all conditions. The total peaker/wind system cost would have to be competitive with conventional baseload equipment.

In considering how to "firm up" wind resources, a higher penetration of geographically dispersed wind plant installations in an interconnected grid tends to reduce the intermittent nature of wind power generation in a grid. However, delivering these resources requires adequate transmission capacity,

which is a challenge for many areas. Wind resources are often remotely located in areas that lack a robust transmission infrastructure.

Conventional power generation equipment is designed to help control and stabilize both grid voltage and grid frequency. During normal operation GE's wind turbines are controlled in a similar way and support both grid voltage and grid frequency stability. GE's wind turbines also contribute to grid voltage regulation even if no wind is present ("WindFree Var" technology).

Recent grid integration technologies have also focused on making wind power plants more robust during grid failures. Similar to conventional power generation equipment, modern wind plants stay connected to the utility grid and help the grid recover from short-term disturbances in a controlled manner ("Low/Zero Voltage Ride Thru" technology).

Despite its variability, there are examples of wind power being treated as a potential substitute for baseload generation. In 2007, the Minnesota Public Utility Commission suspended Xcel Energy's plan to acquire 375 MW of baseload, recognizing that the increase in demand-side management and wind resulting from the state's recently-strengthened Renewable Portfolio Standard would supplant this baseload need.

11) You mention supply chain bottlenecks that have been a challenge to the industry – what are they and what can be done about them?

Gearboxes and bearings are two components that have experienced bottlenecks in recent years. Companies can address these bottlenecks directly by certifying more suppliers, by implementing quality procedures and master production schedules to manage increases in capacity, and by either investing in manufacturing facilities directly or investing in those of our suppliers. GE has made several recent commitments to its US wind supply chain, including

2007 announcements to commit to blade manufacturing companies building new facilities in South Dakota and Iowa, which will together create approximately 1,250 jobs. However, our ability to invest further in manufacturing to forestall bottlenecks is constrained by the uncertainty of US wind policy (particularly the on-again, off-again behavior of the PTC), which does not provide suppliers with sufficient confidence to commit to long-term production capacity expansion.

12) In your testimony you specifically mention that a 10% increase in wind power would be a five fold increase in key components – can you put that in layman's terms? How many more windmills using how much acreage are we talking about under that scenario?

A 10% increase in wind penetration would require that we produce 5 times as many key components as we produced in 2006. By key components we mean the largest parts of a wind turbine—the generator, blade and tower. The estimated megawatt requirement would be 327,000 MW, which would require 218,000 turbines with an average rating of 1.5 MW. According to AWEA, a utility-scale project on flat, open terrain takes up approximately 60 acres per megawatt. Thus, the 327,000 MW would take up 19.6 million acres. However, only 5% of this area—or 1 million acres—would actually be taken up by the turbines and project-related equipment and roads, leaving the remainder available for ranching, farming, and other uses.

13) On page 7 of your testimony you state that failure to extend renewable tax incentives would cause us to forgo long term export opportunities – how much does GE currently export in renewable energy technology?

Policy plays an important role in shaping US renewable energy exports. GE currently exports a significant share of its solar PV technology to Europe due to the presence of strong incentives. However, GE exports of wind technology

from the US are currently limited by the combination of strong domestic demand and a manufacturing base that is immature relative to that of Europe, whose wind turbine manufacturers have capitalized on a stable policy environment to develop a strong base for exports. With a more stable incentive in place in the US, GE and other wind technology companies would have the confidence to expand capacity to meet growing demand both in the US and abroad.

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April 4, 2008

Ms. Aliya Brodsky
Chief Clerk
Select Committee on Energy Independence and Global Warming
U.S. House of Representatives
Washington, DC 20515

Via email

Dear Ms. Brodsky:

I am pleased to submit the following responses to questions posed by members of the Select Committee on Energy Independence and Global Warming as follow-up to my testimony on March 6.

1) How has the development of nanotechnology influenced the solar industry? Where is it headed in the future?

Response: The answer depends on the specific definition of "nanotechnology." Commercial thin-film solar photovoltaic (PV) devices—including thin-film silicon devices fabricated on Applied Material's SunFab manufacturing lines—incorporate very thin films that might meet a broad definition of nanotechnology, namely features (in this case thickness) less than about 100 nanometers (nm). But thin films do not meet the more narrow definition of features that change the nature of the materials properties, *e.g.*, as do the 10 nm dimensions of a so-called nanodot. To our knowledge, PV nanotechnology that meets this more narrow definition is not yet in commercial production at any significant scale.

Nevertheless, PV nanotechnology is an exciting and quickly advancing area of activity in both academic and industrial settings, both here and abroad. For example, some companies are using nanopowders as a simple means of depositing thin films of compound semiconductor materials using low-cost printing techniques; the porous layers of particles are subsequently densified into solid PV films so that the final structure is a more traditional thin-film device.

Other companies use nanotechnology in a key supporting role, for example using a nanostructured matrix of titania that allows the use of organic dyes to absorb sunlight where otherwise the dyes would either be unable to absorb sufficient light or would encounter crippling electrical conductance losses.

Finally, some companies are pursuing nanotechnology as the core concept, by making nanoparticles of sufficiently small dimensions to alter the materials' physical properties (*e.g.*, its light absorption characteristics), or making other equally nanodimensioned objects such as nanorods, nanotetrapods, *etc.*, that exhibit unique optoelectronic properties potentially useful to photovoltaic energy generation.

Any one of these nanotechnologies may mature into a significant contributor to the photovoltaic industry. It is too early to tell which—if any—will do so, but there is every reason to be optimistic. Applied Materials aims to be the provider of choice for equipment and manufacturing lines for these new generations of photovoltaic nanotechnologies when the scale is of consequence.

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2) On the issue of residential versus industrial tax credits – It would seem to me that residential tax credits help to get small scale projects moving quickly, where large scale projects are much harder to pull together for a number of reasons. Would you recommend that we focus more on residential customers and their energy efficiency as we look at tax policy related to solar energy and permit consumers to drive the market?

Response: We agree that it is important that consumers have the opportunity to drive the solar market with their investment dollars and we support extension and expansion of the residential investment tax credit (ITC) as contained in H.R. 5351. As far as solar is concerned, however, the greatest return will be achieved with the business ITC because these projects are larger and can achieve greater economies of scale in deployment. For example, for the equivalent amount of power output, it is easier and more cost effective to implement a one-megawatt PV installation at a business site than to install two-kilowatt systems on 500 different houses. As noted in my written testimony, we strongly favor removal of the ITC utility property exclusion because utility-scale applications (on the order of one megawatt and larger in size) offer the quickest and most cost-efficient pathway to expand the solar market.

3) What is the average cost of a residential project for solar?

Response: The cost of residential solar installations will vary with a number of factors, such as the size of the system and whether the installation is performed on a new or existing home. Installed residential system costs have averaged from $8 per watt to $10 per watt in recent years. Assuming a typical system size of from two to four kilowatts, total installed system costs would range from $16,000 to $40,000.

4) I agree with you that we need to look at the electrical grid for potential "smart grid" solutions. What do you think needs to be done in this area to support solar technologies?

Response: The concept of intelligent or smart grids relates to the creation, flow and communication of information, which allows the electric grid to operate more efficiently and economically, and with greater reliability. Today's radial electricity distribution system is designed for one-way power flow, essentially from centralized generation sources to distributed loads. With limited capacity for reverse power flows and without controls and communication at the point of use, the existing grid is not well prepared to integrate large amounts of solar generation, in either centralized or distributed configurations.

Development and implementation of "smart grid" technologies would allow PV systems to move from passively interacting with the grid to become an active grid partner. As an example, smart controls would allow distributed customer-sited PV systems to interact with customer appliances and other loads to manage variability in the PV system output. When clouds cause PV system output to drop, certain customer loads could be automatically cycled or temporarily curtailed in response; the customer would have the ability to predetermine which loads to shift during which parts of the day.

We support the efforts of the U.S. Department of Energy's Solar America Initiative, which is implementing a research program in advanced distribution systems integration "to configure the PV system to meet system energy demand and control requirements at all grid levels, including transmission and system operation," and encourage Congress to continue funding these activities.

A longer-term challenge to electric grid operation is the ability to integrate very large amounts of intermittent generation sources, such as solar and wind. Electric utilities need to be active partners in

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the development and deployment of smart grid technologies that will facilitate large-scale adoption of clean energy technologies, and the federal government should support these investments wherever possible.

A number of utilities are already pursuing smart grid investments. For example, Southern California Edison recently announced a Renewable Integration and Advancement Program that will "fund and develop innovative systems and technologies to enhance safe and reliable energy deliveries as more intermittent renewable resources come on line." And Xcel Energy announced its intention to implement the first fully integrated Smart Grid City in Boulder, CO, which through the investment and utilization of smart grid technology will provide "operational savings, customer-choice energy management, better grid reliability, greater energy efficiency and conservation options, increased use of renewable energy sources, and support for plug-in hybrid electric vehicles and intelligent-home appliances."

Please let me know if Members of the Committee have any further questions.

Sincerely yours,

Blair G. Swezey
Senior Director
Solar Markets and Public Policy
Solar Business Group

Additional Questions from U.S. House of Representatives
Select Committee on Energy Independence and Global Warming
Associated with March 6, 2008 Hearing Titled
"Blowing in the Wind: Renewable Energy as the Answer to an Economy Adrift"

Barbara D. Lockwood, P.E.
Manager, Renewable Energy
Arizona Public Service Company

1) How much does Solana cost? Is it more expensive than conventional sources of electricity?

Solana will cost over a billion dollars to construct. The actual price of the purchased power contract is confidential. Over the life of the contract Solana will cost about 20% more than we would expect to pay for electricity from conventional fossil fuel resources. Although it is a premium, it is also a fixed price contract and can be considered a hedge against the price risk and volatility of fossil fuels, including natural gas. It is also a hedge against the impacts of potential carbon legislation.

2) Are there supporting U.S. manufacturing opportunities associated with Solana or other CSP projects?

Yes. There are three major components associated with solar trough technology - steel or aluminum for the solar structure, receiver tubes that collect the sun's heat, and mirrors that focus the energy of the sun onto the receiver tubes. Each of these components is somewhat bulky and cost efficiencies may be gained from local manufacturing. There are currently only two receiver tube manufacturers in the world and one of those manufacturers recently announced a new manufacturing facility in New Mexico. We understand suppliers are currently looking at US opportunities for manufacturing mirrors and steel specifically for the Solana plant.

3) Why is APS pursuing CSP today?

First and foremost, Solana will provide dependable on-peak power which is an ideal match for the energy needs of the Southwest. Arizona is growing at a tremendous rate and we need new sources of clean, reliable electricity. With thermal storage, Solana can produce reliable power even when the sun is not shining, which is a tremendous benefit of this technology. The solar industry has also matured in recent years making this type of project viable. The renewable business had been something of a "cottage" industry for many years. Wind began to mature in the 1990's and now solar is maturing. International policies have enticed large, multi-national companies, like our partner Abengoa, to enter into the solar industry. These companies have the financial capability and expertise to make these projects a reality. The global interest in reducing carbon emissions as well as the prospects of US carbon legislation and associated costs are also a consideration. Also, Arizona has a state renewable energy mandate.

4) What will happen to Solana if the ITC is not extended? What if it is only extended one or two years?

Solana will not be completed if the ITC is extended for only a few years. Solana will take between three and four years to permit and construct, and it also costs well over a billion dollars. APS, Abengoa Solar, and the financial institutions providing the funding for this project require certainty that it will be eligible for the ITC once it becomes operational. Without that certainty, the project will likely be cancelled.

5) Why CSP? Why not wind or PV?

Quite simply, solar is by far Arizona's greatest resource and CSP is a great fit for our summer peaking needs. Although we believe there is some potential for development of wind, Arizona is not known as a particularly windy state. In regards to PV, it hasn't been as cost competitive on a large utility scale, and doesn't provide the same level of firm capacity, at least not without very expensive battery storage. Our Solana CSP project was selected through a competitive procurement process (a request for proposals) where it was compared to all sources of renewable energy including wind and PV projects. Solana was more valuable than most of the other projects we looked at, including wind and PV.

6) This project sounds too good to be true – tell me about the challenges. When was the last time one of these projects was built? How sure are you of the cost? Can we do it in Wisconsin?

Several utility scale solar trough plants have been completed recently, including the 68 MW Nevada One plant and a number of international plants, including a 50 MW plant built by Abengoa in Spain. The key components of the Solana project are pretty much tried and true, so the risks associated with the project are scaling up the project to 280 MW, integrating the solar field, storage facility, and steam turbine, and finally simple logistics with a large project (procurement, labor management, etc.) There will be technical and practical challenges as it is permitted, constructed, and begins operation. APS has carefully selected our partner, Abengoa Solar, because of their experience in managing these types of challenges and we believe they are capable of doing so.

As to price, APS has a fixed price contract. There is some risk in commodity prices and construction cost, similar to any other project. Those risks, today, falls on our partner, Abengoa Solar, who has experience in contracting and managing significant international power plant projects.

And no, it most likely wouldn't be advisable to construct one of these facilities in Wisconsin. The technology really depends on very strong sunlight like that available in the southwest.

7) Why CSP? Why not the solar panels that most people talk about?

There are several important differences between CSP and PV, or traditional solar panels. First and foremost is the cost. Photovoltaics (PV) are typically at least twice as expensive as CSP, and APS has not seen any large viable PV projects that are affordable. That may change in the

future, but we know the cost of PV has to decline to make it a viable option. Secondly, PV does not produce the most power when we need it the most. Our peak generation period is in the summer in the early evening hours around 5 to 6 pm. PV systems produce the most power about mid-day and drop off significantly in the early evening resulting in a mismatch in the timing of energy production and periods of greatest energy consumption. Solar trough matched with thermal storage eliminates this issue.

8) The jump from a one-megawatt plant to a 280 megwatt plant is significant – What are the challenges that you face as you build a very large scale solar facility? What was the additional necessary investment due to the high-nature of the project's risk assessment?

As previously stated, the issue isn't so much technology risk, as it is scale. There will be logistics challenges on many fronts. There will be 1500 skilled workers that will need food and housing, and on-site support, recognizing they will be working on a site that is over three square miles. Approximately 2,700 mirrors need to be manufactured, transported, inspected and installed. Enough steel to build a second Golden Gate Bridge - about 80,000 tons – needs to be manufactured, transported, and assembled in a very labor intensive process . APS carefully selected our partner, Abengoa Solar, to manage those challenges and we believe they are capable of doing so. They have worked with these technologies, have established relationships with suppliers and contractors, and have an affiliate that is a successful engineering, procurement, and construction (EPC) contractor.

As to the additional investment, APS has a fixed price contract. There is some risk in commodity prices and construction cost, similar to any other project. Those risks, today, falls on our partner, Abengoa Solar.

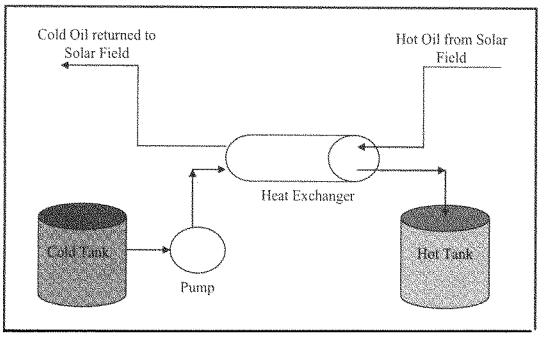
9) What is the projected date of completion for the Solana facility?

If all goes well with permitting and approvals, and the 30% ITC is afforded a long-term extension in the near future, we expect Solana to begin producing power in late 2011.

10) Three square miles is a significant amount of land to take up with a power facility - Are you facing concerns about siting the facility or the transmission lines?

Siting any new generation or transmission is a rigorous process with many facets to be carefully managed for a successful outcome. Although the process of siting has barely begun, Solana is broadly supported by the local community and surrounding communities. We believe any issues identified in the public processes can be successfully addressed.

11) From a baseload perspective I am particularly interested in the heat storage units – can you describe that part of the project further? How long does the heat remain in this tank?



Solana will use an indirect molten salt storage system which incorporates large tanks to store the salt. Pumps transfer the salt through a heat exchanger which is located between hot and cold tanks. During this transfer, heat can be added or removed from the salt.

The thermal energy storage system is charged by taking hot, solar field fluid and running it through the heat exchanger. Cooled molten-salt is taken from cold storage tanks and run through the same heat exchangers. The molten salt is heated and stored in the hot storage tank for later use. When the energy in storage is needed, the system simply operates in reverse to reheat the solar field fluid to generate steam to run the power plant. This process is referred to as an indirect system because it uses a fluid for the storage medium that is different from what is circulated in the solar field. The tanks can retain most of the heat for several days.

12) You note that large scale solar is still more expensive to build than conventional resources – how much more expensive?

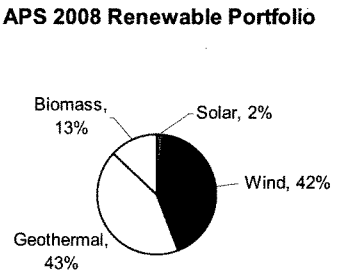
Solana costs about 20% more than we would expect to pay for electricity from conventional fossil fuel resources. Although it is a premium, it is also a fixed price contract and can be considered a hedge against the price risk and volatility of fossil fuels, including natural gas. Carbon legislation could also narrow the cost gap. The actual price of the contract is confidential.

13) Are you a state-regulated utility? How are the costs of this project going to be paid? Do you foresee a rate increase for your customers? How much?

APS is an investor owned utility that is regulated by the Arizona Corporation Commission. Purchased power from renewable resources, like the Solana project, is recovered through two Commission-approved surcharges. Considering that this project does not begin operation until 2011, APS will request any necessary adjustments in 2010. Both surcharges incorporate other elements of cost, and the amount of any surcharge adjustment can not be forecast with certainty today. At any rate, we will need an increase in customer rates to cover the cost of Solana. In the end we don't know for certain if that rate increase will be 20% more than if we added

conventional generation, because the capital and variable costs of conventional generation are unknown and will continue to change.

14) What percent of your power generation is from renewables? What is the breakdown between solar, wind, biomass, geothermal and hydro?



In 2008, renewable resources including solar, biomass, wind and geothermal will provide about 2% of our retail energy needs. The total percentage of energy from renewable resources is expected to increase to over 5% once Solana is in operation for a full year in 2012. The figure at the left shows our projected energy contribution by technology in 2008.

15) Do you feel that you have a good handle on the maintenance costs of a large solar facility? What is the projected life span of the type of solar panels that you are using? What are the unique maintenance concerns that exist?

Facilities similar to Solana have been in operation for over 20 years in the California desert and the operating and maintenance (O&M) costs are well understood. Although APS' contract with Abengoa Solar is for 30 years, we expect this plant to continue operating significantly longer. The O&M for the steam generation end of the facility will be virtually the same as any other steam generation facility operating all over the world today. On the solar side, major maintenance items would include replacement of broken mirrors and receiver tubes as well as typical mechanical and controls maintenance issues. A unique regular maintenance item is washing the mirrors which cover three square miles.

16) With the exponential growth that Arizona faces – is it feasible to think that all of your power generation needs can be met with solar energy or will it require a mix of generation?

Solar energy can not be expected to supply all of our long-term power generation needs. Although it is an excellent "fourth" source of energy, we will need to continue to rely on more traditional resources such as natural gas, nuclear and coal to provide all of the power necessary for our customers. As described in my written testimony, we do believe solar can play a significant in our future resources.

17) You noted the abundance of sunshine in Ariziona, but what is the back up power that would be used to keep the power grid reliable for the 65 days that are not sunny?

APS' portfolio includes a mix of renewable energy, natural gas, coal and nuclear resources. On those days that the sun does not shine, another resource can provide sufficient energy to meet our customers demand. It should be noted that on days with no to little sunshine, our total demand is lower than days with sun, making Solana a good match for our needs. It should also be noted that the thermal storage capabilities of Solana are a tremendous advantage with short duration cloud cover and "monsoon" storms prevalent in Arizona.

18) How many square miles of solar panels would be necessary to equal the output of one 500 MW coal plant or one nuclear plant? How many square miles of solar panels would be necessary to produce 10% of the nation's electrical consumption? 25%? What is the maximum amount of energy solar panels could realistically contribute to the grid by 2020?

Using a project like Solana, matching the output of a 500 MW nuclear or coal plant would require about 15 square miles. To provide about 10% of the nation's energy consumption would require about 120,000 MWs and about 1,500 square miles of land. To provide about 25% of the national energy would require about 290,000 MWs and about 3,600 square miles of solar thermal systems like Solana.

The maximum amount of that solar could contribute to the nation's energy needs is subject to many interdependent conditions including supply chain, transmission development, identifying vast tracts of relatively flat land, and permitting a large number of projects. The Western Governor's Association established a target of 4,000 MW of solar thermal by 2015, and we believe that is a realistic and achievable goal.