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ELECTRICITY GENERATION

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED TENTH CONGRESS

SECOND SESSION

TO

CONSIDER THE VALUE AND EXAMINE THE PROGRESS OF ELECTRICITY GENERATION FROM CONCENTRATING SOLAR POWER

ALBUQUERQUE, NM, JULY 2, 2008

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ELECTRICITY GENERATION

WEDNESDAY, JULY 2, 2008

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Albuquerque, NM.

The committee met, pursuant to notice, at 10:09 a.m. at the International Programs Building, Sandia Science & Technology Park, 10600 Research Road SE, Albuquerque, New Mexico, Hon. Jeff Bingaman, chairman, presiding.

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

The CHAIRMAN. OK. Why don't we go ahead and get started? This is a hearing of the Senate Energy and Natural Resources Committee that I am privileged to chair; Senator Domenici is the ranking member and Senator Sanders is a loyal member of our committee as well.

Let me just give a short statement and then call on Pete to make his statement, and Senator Sanders to make his. Then we will jump into the witnesses.

This is a hearing on a particularly important issue at this point in our history. I think a lot of the focus related to energy nationally is on the price of oil, and that is understandable. We are all worried about that, obviously, and we have tried to do some things with regard to that that we are still trying to add to in Washington.

Today we are focused on the issue of generation of electricity. For years, in fact, since 1978, the Federal Government has been trying to encourage the use of renewable resources for electricity generation. The frank truth is we haven't made much progress. Currently, about 3 percent of our electricity comes from non-hydro power renewables.

I think recently wind generation has been growing at a rapid rate, and over the last 2 years, it has been the fastest-growing source of new generation, which is encouraging. But that still leaves it with a very small share of our generation mix. Other technologies, renewable technologies have lagged behind.

Concentrating solar power, which is the subject of this hearing, has been pointed to as the next inheritor of the mantle that wind now wears. The primary reason that wind power has outdone other renewables is that it is cheaper than other technologies. It is about 8 to 9 cents per kilowatt hour, which is about the same as natural gas. Many in the industry believe that concentrating solar power could reach that price range within 5 to 10 years simply from the

economies of scale that could come from installing a great deal of this capacity.

CSP, or concentrating solar power, has some real advantages over wind. The biggest is that it is less intermittent. In parts of the country where the solar resource is best, such as New Mexico, it is much more predictable than wind. It also may allow for easier storage of energy since it can use heat storage and does not depend on further development of battery technologies. That makes it more responsive to the actual needs of the users of electricity.

There are many reasons for us to pursue the goal of greater deployment of concentrating solar power as well as other renewable technologies. The Federal Government obviously has a significant role to play here. One issue that I know is on the minds of many here is the tax credits that we need to be extending in Washington, and I know there is going to be a continued push to get that done in the next month or two.

I believe, myself, that we should also enact a renewable electricity standard that would require utilities to acquire a set percentage of their electricity from renewables, and of course, we have that in New Mexico at the State level.

Another issue confronting all renewable generators is the inadequacy of the transmission system to carry the electricity that could be produced. We had a hearing on that issue a couple of weeks ago in Washington, and I hope that that hearing leads to some productive solutions on that score.

I wanted particularly to congratulate the utilities—Public Service Company of New Mexico, El Paso Electric, Xcel Energy, and Tri-State—for their announcement this week of a request for proposal for concentrating solar power generators to supply citizens here in New Mexico.

When we get to the witnesses, we are going to call on Greg Nelson from PNM to give us an overview of that proposed project and the reasons why they have chosen this technology to pursue. We have a panel of very distinguished witnesses today, and I look forward very much to their testimony.

Let me now call on Senator Domenici for his comments, and then on Senator Sanders.

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

Senator DOMENICI. Thank you very much, Mr. Chairman.

Might I first say how much we appreciate Senator Sanders being with us? Since you didn't welcome him, don't mind if I do.

[Laughter.]

The CHAIRMAN. You go right ahead, and I am well following you.

Senator DOMENICI. I wanted to tell him how different things are here than in your State. This is a much, much different State. But we know that you love what you have, and we want you to come here and learn about ours so you can love our State. Then all these things that Jeff needs in years to come when I won't be there, you will be voting "aye" every time.

Senator SANDERS. Every time——

[Laughter.]

Senator DOMENICI. If you don't, he will remind you of the pleasantries of today and of the cordiality of New Mexicans. Let me say to everybody here, you know, I don't know why—no reason at all—but he and I have become friends.

[Laughter.]

Senator DOMENICI. We actually go out of our way to shake hands on the floor of the Senate, and that is kind of nice. We smile at each other and almost act like we are long-lost friends. That couldn't be because, you know, I am so much older than him, we couldn't be long-lost friends. But I do want to say that I not only appreciate you being here, but I very much appreciate the hard work you do. Whether I agree with you ideologically on whatever it is, I am a fan of your hard work.

Let me say I have a prepared statement that this wonderful staff of mine has prepared. But I think Senator Bingaman covered it. So if you don't mind, I am just going to put it in the record with your permission, Mr. Chairman.

The CHAIRMAN. Very good. Included.

[The prepared statement of Senator Domenici follows:]

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

Thank you, Mr. Chairman, for calling this hearing on an issue of enormous potential—Concentrating Solar Power. I am pleased to be back here at Sandia today and I'd like to welcome Senator Sanders from Vermont to our great state.

According to the Energy Department, "more energy from sunlight strikes the Earth in one hour than all the energy consumed by human activity on the planet in one year." I find that remarkable—just one hour of sunlight contains more energy than is used worldwide for an entire year. New Mexico is truly blessed to have this abundant, carbon-free source of energy—if we can harness it.

There is no question that America needs to become less reliant on foreign sources of energy. Over the last several weeks, I have been telling Americans that we are on the verge of economic destruction if we do not address the high price of gasoline.

I believe that we need to increase American production of oil by opening up new areas for exploration as soon as possible. But this oil production in the near term will provide us with a bridge to a clean energy future. On the other side of that bridge is an economy driven by clean energy technology like solar panels.

The good news it that our government has already invested literally billions of dollars for research and development of renewable technologies like wind, biomass and solar. In fact, for solar alone, we've spent more than $4 billion. And there are billions more to come for all forms of alternative energy.

One of the most important issues facing the solar industry right now is that tax credits that we passed in a bipartisan manner to help spur development are set to expire. It is of critical importance that they be extended—as soon as possible.

Congress has passed tax credits for renewable energy six times since 1992. Unfortunately, the Majority in the House of Representatives has decided to change the way we pass these credits by requiring that they be "offset" by tax increases on other industries.

Requiring "offsets" to provide tax credits for renewable energy makes little sense, particularly in light of a new study released by General Electric that shows that the renewable energy tax credits already pay for themselves. By spurring the growth of a new, clean technology industry, the renewable energy tax credits provide the government revenues from the projects' income, vendors' profits, and workers' wages.

In addition, Congress has never before required offsets for renewable energy tax credits. By setting a precedent that from now on, offsets will be required, the Majority is putting the renewable industry in the difficult position of having to fight for tax increases every single year. I believe that this is a bad precedent to set.

The Albuquerque Journal echoed this sentiment in a recent Op-Ed calling on Congress to move forward on a bipartisan bill. The Senate has already done so by approving the Cantwell/Ensign energy tax package by an overwhelming vote of 88-8. It is my hope that the House Majority will drop their objections to passing a clean

extension of renewable energy tax credits and pass this bipartisan package as soon as possible.

Thank you, Chairman Bingaman, for convening this morning's hearing. Our impressive panel of witnesses are involved in all aspects of the solar industry—from performing the R&D work, to manufacturing plant receivers, to building the CSP plants, and finally, to purchasing the resulting electricity. I thank you all for being here today and I look forward to your testimony.

Senator DOMENICI. I just want to say thanks to all you witnesses who are lined up here. I know you have something to contribute, and we want to hear it.

I, myself, in preparing for this hearing, was a little bit aghast by the Spanish company. In their notebook, they had prepared a trend line of how long it takes from starting a plant to building one. I was quite amazed, and I hope you will tell us all about that.

I hope that isn't the national standard. I read your notes. It takes 6 to 8 years from the time you get ready to do one of these until you break ground. That is almost as long as a nuclear power plant, and I don't think they are quite as complicated. But perhaps I am missing something.

The other point I wanted to make is that it doesn't sound possible, but, you know, the Sandia National Laboratory was working on this kind of solar energy early in my Senate career. I mean, it was like 30 years ago we used to go out and look at the troughs, which is one kind of concentrated solar, and they would show us what the shortcomings were. Then they would solve those, and there would be another one.

But I continue to be amazed at not you, Sandia, but just at America, how long it takes to go from the research to the development to the actual application. Let me just say I don't think we can afford 10, 15 years on big energy projects that substitute even directly or indirectly for crude oil.

I don't think we can sit by and let those projects take 8, 10, 15 years to reach fruition because I believe the dependence on crude oil is real, and we can't get out from under it, no matter how hard we try, for a long, long time. That is a destructive thing. It is destroying our economy. This huge amount of money we send overseas is unbearable for the great country called America.

We won't stand to spend half a trillion a year for 10 years while we wait around for some substitute. Can't happen. We can't let it happen. Even your great project won't be around. But as it is, we aren't going to have the resources hanging on for so long. So I am very concerned about how long it takes for alternative energy development.

Last, but not least, I do know, without the testimony, that we must have a tax credit, the 30 percent that you all know we need, for the kind of solar we are talking about. I know some people blame us Republicans, and we Republicans blame them.

[Laughter.]

Senator DOMENICI. What we really have to do is we have to decide who is going to give. I don't know who is going to give yet and how long it will take. But we act one way based on what we think is a good rationale, and the Democrats—because of the House, Democrats in the Senate act another way, and we don't get anywhere.

But I will tell you, I support it. So don't put me in an "anti" position. I support it wholeheartedly. I don't know how to get around the problem unless Senator Bingaman and I decided that we might come up with a bipartisan substitute, and maybe we will. I don't know. We might try when we get back. If we did, it would go. It would pass. But we haven't been able to do that yet.

So please understand you can blame whomever you blame, but I have a good answer for why I can't vote for the way it is being done, and he has a great answer for why they are voting the way they are. We both want it done, and we voted 88 to 8 at the last vote for you. So you know it is bipartisan.

With that, thanks for calling the hearing, Senator Bingaman.

The CHAIRMAN. Thank you very much.

Let me just say a few words of welcome and introduction.

[Laughter.]

The CHAIRMAN. This hearing really is being held at the urging of Senator Sanders. He has been urging me now for several months to have a hearing on concentrating solar power. I suggested we do it out here in Albuquerque, which he was very agreeable to, but that somewhat explains his presence here. He is a great advocate for all renewable energy sources. In particular, this very much, I think, as his own statement will indicate, he is very much aware of the potential of this particular technology.

So, Senator Sanders, thanks for being here.

STATEMENT OF HON. BERNARD SANDERS, U.S. SENATOR FROM VERMONT

Senator SANDERS. Senator Bingaman, thank you very much for welcoming me here. Senator Domenici, thank you very much for your kind words.

I just want to tell the people of New Mexico that you have two great Senators. At this particular pivotal moment in American history regarding energy, we are all fortunate to have Senator Bingaman in the chair.

I can also tell you that while Senator Domenici and I certainly have differences of opinion, there is nobody in the Senate, I think, who is more respected and better liked than Senator Domenici. I just want to thank you for your years of service not only to the people of the State, but to the entire country. Thank you, Pete.

This is an extraordinarily important hearing and an extraordinarily important moment in American history. I don't want to renew the debates that are taking place in Washington. I happen to believe global warming is real. It is of enormous consequences to this planet. If we do not get our act together, our children and grandchildren will be living on a planet with a significantly inferior quality of life.

What we are already witnessing is increased droughts, flooding, severe weather disturbances, the CIA and the intelligence agencies telling us that as water disappears, as food land disappears, there is going to be increased international conflict and war. I think we have no alternative but to move aggressively and boldly in addressing this international crisis. I want to see this great country once again be a leader in the world in going forward in terms of energy efficiency and sustainable energy as we do it.

So the bad news is we have a very serious problem. But there is good news out there, and the good news is that we know how to address this crisis.

The other very good news is that it is not just intellectual knowledge. We now have the technology to do that as a result of extraordinarily good scientific work, including the work done here at Sandia, and engineering work done all over our country. The tools that we need are moving forward aggressively, in my view, in energy efficiency, an area my State has done a very, very good job, and moved forward in such sustainable energies as solar, wind, geothermal, biomass.

I happen to believe that solar, especially concentrated solar, has extraordinary potential to produce huge amounts of electricity, and we are right in the middle—right here in New Mexico, Nevada—right in the middle of the area that has the capacity to do that. There are scientists and, I expect, people who will be testifying today who will tell us that within a reasonably short period right here in the Southwest, we could produce 15 to 20 percent of the electricity that we need in the country. In years to come, we can do even more than that. That is extraordinary.

Second of all, in terms of the cost of this electricity, what even the folks at Sandia are telling us that the more electricity we produce, the more we learn about this technology, the cost will go down. It will be competitive or maybe even be more competitive than other fuels that we are using today.

Third, as we clean up our environment, as we begin to reverse global warming through concentrated solar, through photovoltaic technology, through wind, through geothermal, through biomass, we are also going to create millions of good-paying jobs. Sometimes I get a little bit tired, the Senators and I hear folks are saying, well, the world is coming to an end, you know? It is going to be a great economic disaster.

As we move forward in new technologies, I believe absolutely the opposite. I believe there is enormous economic potential not just for the Southwest, but all over this country in creating good-paying jobs. I want to thank Senator Bingaman, Senator Domenici. On the energy committee, we have made some progress in the recent energy bill. But we have a long way to go. We do. But that was a good bill. It was a bipartisan effort, and we have made some progress.

Let me just, if I might, Mr. Chairman, voice one note of concern before we hear from our very distinguished panelists. Some of you may have heard that the Bureau of Land Management recently announced a moratorium on accepting new applications for concentrated solar plants. I think that that is very unfortunate. I will do everything that I can to rescind that edict.

Right now, there are approximately 150 applications that the BLM people are currently processing. To the best of my knowledge, not one application has yet been accepted. The reason that I hear, if you can believe it in the midst of this grave crisis of global warming, as I understand it, we have two people who are processing these claims. Two people.

So here we are, trying to reverse global warming, create millions of good-paying jobs, we have got a bottleneck with two people pre-

sumably working very hard. We have got about a $3 trillion budget. I think we can afford a few more people to process these claims, and we will be trying to do just that.

So I am excited about this hearing. In Washington, we all hear a lot about nuclear, and Senator Domenici and I may have some disagreements on that. We hear about carbon sequestration, and I have my doubts about that. We are not hearing enough about the potential of solar in general and concentrated solar in particular.

I think this is the most exciting, sustainable, energy concept that we have out there, huge potential. So I thank you very much, Mr. Chairman, for holding this hearing and look forward to hearing from our distinguished panelists.

The CHAIRMAN. Thank you very much.

I think, since this may take us a little time to get through all the witnesses, I am going to take off my jacket. I urge all the witnesses or panel members to do the same, so that we don't get too hot around here.

The beginning of this hearing is going to be Greg Nelson, who is with PNM. He is the person who is in charge of this recent proposal that has come out for a request for proposal. I asked if he would go first before the other witnesses and sort of frame the issue and indicate to us what has led PNM and the other utilities to this point of looking at this particular technology, this concentrating solar power technology and what they anticipate going forward with this.

So, Greg, thank you very much for being here on short notice. Please go ahead and give us an overview on this, and then we will call on each witness.

Our normal practice here in the committee is to give each witness 5 or 6 minutes to summarize the main points they think we need to know. We will include any statements you would like in the record in full, but I think that is the most useful thing. Then after we hear from all witnesses, we can ask some questions.

So, Greg, go ahead.

STATEMENT OF GREG NELSON, DIRECTOR, UTILITY SERVICES, PNM RESOURCES, ALBUQUERQUE, NM

Mr. NELSON. Thank you, Senator.

Senators, it is a pleasure and an honor for me to be here today to represent PNM, Public Service Company of New Mexico, to talk about our plans for solar power. We firmly believe that solar power is very important not only to our company, to our State, but also to the citizens of the United States.

With that, I would like to tell you a little bit about our RFP and the process that led us to issuing this RFP. Back mid-year of last year, we initiated a multi-utility study with the Electricity Power Research Institute as the project manager for that effort. EPRI engaged solar energy experts, engineering firms in the likes of Black & Veatch and Nexant, to support that effort.

We also had several Federal partners in that project that included the Department of Energy, Sandia National Labs, and NREL. We also engaged a State partner in terms of the New Mexico Energy, Minerals, and Natural Resources Department, and we also included environmental stakeholders in the process.

The multi-utility study, as I said, was headed up by EPRI with PNM as the initiating partner. Other utilities involved in that process were Xcel Energy and their affiliate SPS, El Paso Electric, Tri-State's Generating and Transmission, San Diego Gas and Electric, and Southern California Edison. The purpose of the study was to identify the most commercially viable solar technology for a central station solar plant located here in New Mexico.

After an exhaustive study, the conclusion was that based on the status of the technology, solar trough was the most applicable technology and a technology that was cost effective enough to move forward with a large project. Secondary issues related to the study included appropriate siting criteria, looking at water constraints, as well as transmission constraints.

Based on the results of that study, four utilities decided to move forward with a central station RFP. Those four utilities were PNM, SPS Xcel, El Paso Electric, and Tri-State. We have joined together because we believe, one, it is the right thing to do. The sum total of the four utilities represent the vast majority of the electric users here in the State. We believe that joining together for a large central station facility makes economic sense. It helps bring down the cost of the plant and, therefore, the cost to each of our customers.

We, this week, issued an RFP for a facility in the range of 211 gigawatt hours to 375 gigawatt hours. That range is equivalent to a facility without storage of approximately 110 megawatts up to 195 megawatts. With 6 hours of storage, we expect that would go from 65 megawatts to 120 megawatts.

Criteria that we have in place is that the facility must be located in New Mexico. We believe, according to NREL data, that we have the second-best solar resource in the Nation, and we want to take advantage of that for our customers and for the citizens of New Mexico. We issued the RFP, like I said, this Monday. We are giving respondents a couple of months to respond to it.

We hope to have a PPA, a power purchase agreement, negotiated and in place by the end of this year, and we hope to have a facility online by the end of 2011. That will not only help us meet our renewable energy RPS requirement, it will also help us bring clean energy to the citizens of New Mexico.

Senator DOMENICI. What will be ready by 2011?

Mr. NELSON. We hope by the end of 2011 that we will actually have a plant online and generating.

Senator DOMENICI. Delivering?

Mr. NELSON. Delivering power to our customers. Yes, sir. Fully commercial by the beginning of 2012.

The CHAIRMAN. Very good. Did you have any more detail you want to give us at this point?

Mr. NELSON. I would be happy to open it up to questions. But we are putting it out on an energy purpose or on an energy basis, where we will be purchasing the energy off of that project along with the renewable energy certificates that go with it.

The CHAIRMAN. Are you requiring as part of the RFP—one question that occurred to me—that the 6 hours of storage be built into the unit so that there will be storage capacity?

Mr. NELSON. The RFP was formulated to be as flexible as possible to the vendors, looking for them to come up with creative

ways to bring down the cost of energy as much as possible. We believe storage plays a large role in that. We have encouraged the RFP bidders to propose storage in there, to come up with a cost-effective level. But we do encourage them to look up to 6 hours of storage associated with the project.

The CHAIRMAN. Pete, did you have a question?

Senator DOMENICI. Yes. What is the nature of the property upon which the central plant would be located?

Mr. NELSON. We did not specify properties, although we have had a number of interested stakeholders offer up their property for the siting of this facility. Again, we wanted to leave that up to the bidders, again, to give them the flexibility to come in with the most cost-effective project they can.

Senator DOMENICI. Do you know in advance, having researched it, whether there will be right of way problems or right of way necessities that are going to have to be met?

Mr. NELSON. The right of way challenges we expect to face will vary depending on the location proposed. As I am sure you are aware, right of way and transmission constraints here in New Mexico are very significant. So there are certain parts of the State that are tougher to get the power back from than others. When I say "get the power back," I am talking to basically our load center, which here in New Mexico consists of the Albuquerque/Santa Fe area.

Senator DOMENICI. Mr. Chairman, I am sure that given time we will be inquiring, but not today. We don't have enough preparation, but I think it is good that you brought them. It makes the hearing much more relevant because we are right in the middle of an event of significance to us. Thank you for that.

The CHAIRMAN. Bernie, did you have some questions?

Senator SANDERS. I did. Mr. Nelson, did I hear you say that you thought, if things go the way you wanted, you could break ground inline and be producing electricity in 2011?

Mr. NELSON. We hope to, if all goes well with our engaged partner—and we look at the ultimate person that we sign the PPA with as being a true partner in the development of renewable energy. We hope to break ground in the 2009, early 2010 timeframe and have the project online by end of 2011, worst case early 2012.

Senator SANDERS. One of the exciting attributes of concentrated solar is the speed. In fact, I think Senator Domenici pointed out, purposely so, it is not a complicated technology. In fact, the generation aspect is traditional. It is what they do with coal and gas. The speed at which one can move these things, given the crisis that we face as a Nation, is one of the attributes of solar power. I think you have indicated that?

Mr. NELSON. Yes, sir. As you may be aware, a number of the large solar firms have done solar prospecting here in the State and identified sites, have supply chains set up. So we expect that construction should take, for a facility of this size, on the order of a year and a half timeframe. So that, with their site lined up, with their supply chain in place, we believe that the 2011 timeframe is a reasonable timeframe.

The CHAIRMAN. Thank you very much for being here and giving us that overview. Congratulations on moving ahead with this. I think it is a great project.

[The prepared statement of Mr. Nelson follows:]

PREPARED STATEMENT OF GREG NELSON, DIRECTOR, UTILITY SERVICES, PNM RESOURCES, ALBUQUERQUE, NM

INTRODUCTION

Good morning Chairman Bingaman, Senator Domenici, Senator Sanders, and distinguished Members of the Committee on Energy and Natural Resources. Thank you for inviting me here today. I am Greg Nelson, Director of Utility Services for PNM Resources.

PNM Resources is an energy holding company based in Albuquerque, N.M., with consolidated operating revenues of $2.4 billion. Our electric generation is primarily a mix of coal, nuclear, wind and natural gas. Through its utility and energy service subsidiaries, PNM Resources supplies electricity to 738,000 homes and businesses in New Mexico and Texas, natural gas to 470,000 customers in New Mexico, and electricity to numerous wholesale customers throughout the southwest. Its utility subsidiaries are PNM, TNMP and First Choice Power, a deregulated competitive retail electric provider in Texas. In November 2006, we announced a Joint Venture with Cascade Investments for the purpose of long-term investment in both wholesale and retail electricity sales, electricity generation and energy trading.

PNM Resources is committed to diversifying our generation. As Director of Utility Services, one of my main responsibilities is to oversee renewable generation, including wind, biomass, and most importantly for this hearing, solar, from inception to commercial viability for PNM Resources.

SOLAR

According to the National Renewable Energy Laboratory, New Mexico is one of the best solar resource capability in the nation. We firmly believe solar power is not only important to our company and to our state, but also to the US.

In 2007, we initiated a multi-utility study that included Xcel Energy, El Paso Electric Company, Tri-State Generating and Transmission Association, San Diego Gas and Electric, and Southern California Edison. Leading this study was the Electric Power Research Institute, who engaged solar experts and engineering firms in the likes of Nexant and Black and Veatch. We had several federal partners in the project, including the Department of Energy, Sandia National Laboratories, and the National Renewable Energy Laboratory. We also engaged the New Mexico Energy and Natural Resources department and environmental stakeholders including Western Resource Advocates and the Coalition for Clean and Affordable Energy.

The purpose of this study was to identify the most commercially viable solar technology for a central station solar plant located within New Mexico in the 2011 to 2012 timeframe. It was determined after an exhaustive study that, based on the status of current technology, solar thermal parabolic trough is the most applicable and cost efficient technology for a large project in this timeframe.

Based on these results four utilities, PNM, Xcel Energy through their affiliate Southwestern Public Service Company, El Paso Electric, and Tri-State Generating and Transmission Association moved forward with a central station parabolic trough Request For Proposal (RFP). The sum total of these four utilities represents the vast majority of the electric users in New Mexico. We believe that joining together for a large central station facility makes economic sense; thus bringing down the total cost of the plant for each utility, and subsequently lowering the cost of providing solar energy to each of our customers.

On June 30 we issued an RFP for a facility located within New Mexico in the range of 211 gigawatt hours to 375 gigawatt hours. That range is roughly equivalent to capacity of 110 to 195 megawatts for a facility without storage, and from 65 to 125 megawatts for a facility with six hours of thermal storage. We are expecting to enter into an energy only contract, i.e. no capacity payments, in which we also receive all renewable attributes.

We believe storage will play a large role in any future solar facility. Consequently, we have encouraged the RFP bidders to propose up to six hours of storage, but allow bid flexibility for cost effectiveness.

Our goal is to have a Power Purchase Agreement negotiated and in place by the end of 2008 and a solar facility commercially available by the end of 2011.

CONCLUSION

Thank you for your time and consideration. I would be pleased to answer any questions you might have and I look forward to being of service in any way I can to this Committee.

Footnote

The issue of time of use (TOU) rates was raised during the question and answer session. PNM does not currently have TOU rates for residential customers, whose usage typically drives utilities' peak loads. TOU rates are intended to pass real time pricing signals through to consumers, which allows them to make energy consumption decisions. Generation is typically dispatched on an economic basis meaning that cheaper sources of generation are initially utilized followed by increasingly more expensive sources. This translates to higher costs of energy during high usage periods. Consequently, TOU rates financially incent lower usage during these high cost times. Renewable energy resources that harness the sun's power typically align well with utilities' seasonal and daily load shapes, meaning that there is good correlation between solar availability and high use time periods. Solar plants produce the most energy during the summer months when energy demand is the highest, and less in the fall, winter and spring when energy demand is lower. With the implementation of TOU rates, the cost of solar generation will be compared with the higher cost generation that is online during high use times, thus making generation from solar resources more attractive.

The CHAIRMAN. Yes, Senator Domenici.

Senator DOMENICI. Could I just, for the record, make an observation about right of way? I think people might wonder if you and I worked awful hard to put together the Energy Policy Act, which includes a major section on right of way, how we get right of ways, when right of ways have run into a stone wall, so as to speak. You hear and I hear from some that we shouldn't have done that, that we shouldn't have provided a way to break the stalemate.

I want to say that those who think that Republicans ought to be against eminent domain when you run into a wall, I was heavily in favor of the right of way that we put in. You can attest to that, and I still am. If there are any of you up here who are going to be complaining that we shouldn't have done that, I want you to know that the more you complain, the more I am for changing it.

But I am for changing it to make it stronger because I think it is ridiculous for us to be holding up major projects because we have some ideological bent that States must control. We are in a crisis. We have got a big plant like this, and you have to cross State lines, and you have to find a right of way. I hope our section, which is really not very tough—we were pretty generous because we didn't want the bill to get killed on the floor of the Senate.

So, it is there. It is no question that the commission has the ultimate authority, and I am sure you are aware of that. You would probably vote for it again if we had it again, wouldn't you?

Senator SANDERS. I think the point that you are making is everybody—you know, we can complain and moan and groan, but if we are going to go forward, we need to take bold action. That, by the way, is true with wind as well. In my State, I have to tell you, there is overall sentiment for wind. But people say, hey, we don't want to look at wind turbines.

Sorry. If we are serious about breaking our dependency on foreign oil, we are all going to have to do something maybe that we are not 100 percent for.

Senator DOMENICI [continuing]. It may save time.

The CHAIRMAN. OK. Let me just briefly introduce the rest of our witnesses here.

Charles Andraka is with Sandia National Labs. We appreciate you being here. He is going to give us an overview of this technology and how it compares with others.

Fred Morse is with Abengoa Solar, headquartered out of Spain, I believe, but very much sort of a leading provider in this area.

Mike Daly is right here with Mesa del Sol and is going to talk about their efforts to create solar power capability here at Mesa del Sol.

Alex Marker is with Schott Solar, which, of course, is in the process of building their production or manufacturing facility in Mesa del Sol, and we are very excited about that. He is going to talk about what they see as the prospects for concentrating solar.

Fong Wan is representing Pacific Gas and Electric, and they have been a leader in the use of solar energy technology. He is here from San Francisco. So we really appreciate him coming very much.

Mr. Andraka, why don't you start off and give us 5 or 6 minutes? Then we will just go down the line and hear from all of you, and then we will have questions.

STATEMENT OF CHARLES E. ANDRAKA, SANDIA NATIONAL LABORATORIES, ALBUQUERQUE, NM

Mr. ANDRAKA. Thank you. Good morning, Senators.

My name is Charles Andraka. I am a distinguished member of technical staff at Sandia National Labs, and I have worked as an engineer in concentrating solar power, or CSP, for the last 23 years.

CSP, as you know, uses mirrors to concentrate sunlight to create an intense heat to drive a conventional engine or turbine. Why CSP? First of all, CSP is highly scalable. It is built with glass and steel, similar to our automotive and building industries. CSP makes grid-ready AC power because of the rotating machinery involved.

CSP is proven technology with over 400 megawatts of CSP deployed and operating in the Southwest United States at this point. CSP can incorporate storage. This allows smoothing of short-term transients as well as shifting the peak to match utility needs.

CSP can be hybridized to burn natural gas or other fossil fuels for firming capacity. CSP is efficient with a world record efficiency of 31.25 percent conversion of sunlight to grid-ready electricity in a commercial installation.

I want to talk about the potential for CSP or why CSP now, why the big interest? First, the Southwest U.S. has an incredible resource. We like to call this "the Saudi Arabia of solar energy." We have identified in easily reachable resources nearly 7 terawatts of generating capacity. That is about 7 times the current electric-generating capacity in the entire country.

The second area is the renewable portfolio standards, particularly in the Southwest United States. There is a large amount of solar needed to meet these standards, and the ramp-up rate can be met with CSP technology as part of a renewables portfolio. This would be combined with wind, PV, geothermal, and hydro.

Third is the current public interest in CSP. This is driven by the current energy situation as well as concerns about global warming.

Finally, the DOE laboratories' development over the last few decades has led to an unprecedented technology readiness for deployment of these plants. This has led to a current publicly announced deployment plans of 3 to 4 gigawatts of power, and that is equivalent to 6 to 8 new coal plants. Many more plants are in the initial planning stages.

I want to talk a little about the barriers to CSP deployment. The first is financial risk. As you know, these are large capital expenses rather than fuel costs distributed over the life of the plant. So there is financial risk up front, and there is technology uncertainty, particularly with the towers and dishes. The troughs have less of that uncertainty because of the deployed projects. The ramp-up to manufacturing at a high rate is needed to reduce the cost. So there is that chicken and egg syndrome.

The second barrier is taxation policy. The capital expenses on these plants tend to be taxed as property. California, as well as other States, waives the property tax on these systems and is leading the way in this area. The longstanding 10 percent ITC and other considerations level the taxation on an energy basis with conventional power generation. However, the 30 percent ITC would help overcome some of the initial financial risk.

The bottom line on the taxation policy is we need long-term financial policy stability for these plants to go forth. You have already mentioned the time it takes to permit. If the ITCs run out during that time, it is hard to get financing for these plants.

The third area has already been mentioned, and that is transmission capacity. This is the greatest consideration we are facing when siting new plants. We find we are not in the energy generation business, we are in the transmission business when we are trying to site these plants. The capacity of a current transmission grid is much smaller than the plants that are proposed and on the books at this point.

Senator DOMENICI. What is that?

Mr. ANDRAKA. The capacity of the existing transmission grid is much smaller than the plants that are already on the books, these 3 to 4 gigawatts worth of plants.

Finally, the final barrier is the approval processes. The Federal, State, local, and utility processes are often cumbersome. There is nothing in place for the current onslaught of solar plants. The codes and standards need development. The local authorities are scrambling, trying to find a consistent code to apply to these plants because there is nothing out there like this.

I want to talk a little about the laboratory role. The laboratories play a critical role in facilitating the rollout of the concentrating solar power technologies into the marketplace. We are working hand in hand with industry right now. We also continue to play a critical role in the development of advanced systems with lower costs and higher performance.

We see a three-prong approach for laboratory involvement. A key effort right now is commercial development support, where we leverage the incredible laboratory experience to assist the commercial companies technically.

The second area is supply chain development, where we need to identify and exploit synergistic supply chains, such as the auto-

motive industry. Along with supply chain development is supply chain development of personnel. We need to increase our involvement with universities and increase our internship programs.

A third area that the labs need to be involved in is revitalization of advanced development of CSP technologies. This leads to new technologies with step cost reductions, not just the manufacturing quantities. We need to do, as the laboratories of things industry doesn't even know they need yet. We have a significant track record over the last decade of identifying those areas, developing technologies, and those technologies are now being used by industry.

In summary, CSP has the potential to meet a large fraction of our energy needs in a portfolio with other leading renewables. The easy-to-reach resources in the Southwest are capable of 7 times the current generating capacity of the United States. CSP leverages existing U.S. manufacturing capabilities. Current market drivers have led to unprecedented interest in CSP.

Deployment acceleration requires improvements in taxation, regulatory, and approval processes and policies. The support of the national laboratories has been and will continue to be crucial to the success of commercial CSP projects. Continued industry support, supply chain development, advanced technology research, and stable policies will allow us, as a Nation, to take advantage of the tremendous energy resource identified in our own backyard.

Thank you.

[The prepared statement of Mr. Andraka follows:]

PREPARED STATEMENT OF CHARLES E. ANDRAKA, SANDIA NATIONAL LABORATORIES, ALBUQUERQUE, NM

INTRODUCTION

Concentrating Solar Power (CSP) describes a suite of solar technologies that use mirrors and thermodynamic processes to develop grid-ready electricity. Mirrors on tracking structures concentrate sunlight, producing high temperatures, which then drive conventional or novel engine cycles that in turn drive a generator to develop electricity. CSP technologies do not depend on strategic or high-tech materials, but rather are based fundamentally on glass and steel structures. The collected energy can be stored as thermal energy—an inherent advantage of CSP over photovoltaic solar and wind electrical generation. While CSP technologies are not as recognizable as photovoltaic power (PV) technologies, there are nearly 450 MW of CSP generation currently operating in California and Nevada, with additional planned deployments of over 3000 MW in the Southwest United States.

CSP has the potential to supply a large fraction of the energy needs of the United States, although prime generation sites exist primarily in the Southwest. Working in conjunction with other renewable resources established in other parts of the country, and with improvements to the grid infrastructure, the future of CSP in the nation's energy portfolio is indeed bright. The current cost of electricity generation by CSP trough plants is about $0.16/kWh. Other CSP technologies may produce lower cost electricity due to higher system efficiencies. With further technology development and increased deployment, the cost of CSP-generated electricity projected in several studies to reach $0.06/kWh. In addition, the high-temperature capabilities of CSP make possible highly efficient chemical processes that can lead to solar fuels production.

The DOE national laboratories, specifically Sandia National Laboratories and the National Renewable Energy Laboratory (NREL), have played a crucial role in existing CSP deployments, and we continue to work closely with industry to optimize and improve the designs and plans for upcoming deployments. The historical and ongoing technical achievements at the laboratories have been and will continue to be a cornerstone of successful cost reduction, performance enhancement, and deployment success. Key laboratory-developed technologies are deployed to the field by in-

dustry. The test capabilities at Sandia are unmatched worldwide, and provide a great resource to industry partners.

CSP DESCRIPTION

CSP converts the sun's energy into heat and then uses that heat to power an engine-generator unit. The sunlight is concentrated with mirrors—similar to concentration by a magnifying glass. The resulting heat is intense enough to create steam to drive a conventional turbine or to heat a working fluid in a smaller engine, similar to burning gasoline in an automotive engine. CSP technologies are large-scale, providing utility-scale generation of power, with near-term planned plant sizes ranging from 100 to 1000 MW. (A typical coal or nuclear plant may be 500-2000 MW.) CSP consists of three basic technologies: (1) parabolic troughs, (2) power towers, and (3) dish-engine systems. Each of these technologies uses a parabolic array of mirrors, on different scales, to create intense heat.

CSP is already being deployed, with 384 MW of capacity in nine plants in California and a new 64 MW plant in Nevada. Combined, these plants represent more than 140 plant-years of commercial operation. The national laboratories have continued to develop the CSP technology and have also helped improve the deployed plants. In 1998, the nine plants in California increased their rated capacity from 354 MW to 384, in part because of performance and operations and maintenance improvements pioneered by the laboratories. Over the last two decades, new deployments have been limited by the relatively low cost of electricity generation by natural gas. The recent dramatic increases in fuel cost, coupled with the Renewable Portfolio Standards (RPSs) in some states, have driven renewed interest in CSP deployment. The addition of the 30% Investment Tax Credit (ITC), as opposed to the 10% level, offsets some of the financial risks inherent in initial scaled-up deployments.

A key advantage of CSP is dispatchability (that is, the ability of a generating unit to increase or decrease generation, or to be brought on line or shut down at the request of a utility's system operator). Because the energy conversion process is a thermal action, the solar input can be supplemented in two ways. The first is through thermal storage, in which a working fluid is stored hot and then used when needed to drive the turbine. This process is very efficient, with over 98% recovery. The second is that systems can be "hybridized".where an alternate fuel such as natural gas can be burned to supplement the solar collection. This method is not as desirable as storage, but it does present an option that photovoltaic and wind energy sources do not provide.

A second advantage of CSP is the inherent "low tech" of the materials involved. The collection structures are typically steel or aluminum, with glass reflector surfaces. The resulting structures have been likened to "a funny-looking car." Indeed, several industry partners who work with Sandia have already leveraged the manufacturing capabilities of the Detroit-area automotive companies, as well as other basic American manufacturing companies.

TECHNOLOGY DESCRIPTIONS

Parabolic Troughs

The parabolic trough system is a line-focus mirror array, as opposed to a point focus system. At the focal line, a specialized tube carrying a working fluid (such as a thermal oil or a molten salt) is heated. The working fluid reaches temperatures in the range of 500°C. The collected heat can then be stored or directly passed through a heat exchanger to generate steam for a conventional turbine.

This technology is the most widely deployed CSP approach, and existing deployments help in obtaining funding and approvals for new installations. The state-of-the-art systems are solar-only (no storage), with an annual efficiency in the 12-14% range and a peak efficiency of about 16-18%. Typical plants in the past were sized under 50 MW due to power purchase agreement limitations. The newest plant, in Nevada, is a 64 MW installation. Proposed plants for Arizona are as large as 280 MW with storage. The larger size plants bring down the cost of the electricity generated through economies of scale.

Current trough research includes thermal storage development and testing, higher temperatures (which leads to higher performance), and lower cost designs. Key laboratory optical modeling and systems development approaches are helping industry to reduce costs without reducing performance.

One key component of trough systems is the receiver tube, a glass and metal structure that includes some laboratory-developed sealing technology. The Schott Solar Company is planning to build a plant in Albuquerque to fabricate this critical component.

Dish Engine Systems

Dish-engine systems consist of a tracking dish that concentrates sunlight to a single point, and a heat engine at that point which converts the intense heat to electricity through a rotating shaft and generator. Current designs center on a Stirling cycle engine, which is similar in many respects to automotive engines. Dish systems currently range from 3 to 25 kW capacity each, although larger systems are envisioned by some companies. Most companies currently developing dish systems intend to deploy fields of dishes, with aggregated capacities up to 1000 MW (for example, 40,000 25 kW dishes in one field). This deployment approach is seen as key to cost reduction.

Because of the point focus at each dish, the dish system is capable of very high temperature operation, typically in the 800°C range (glowing red to orange). These high temperatures lead to very high system efficiencies for conversion of sunlight to grid-ready electricity. The current world record solar conversion efficiency is 31.25%, held by the Stirling Energy Systems 25 kW Dish-Stirling system located at Sandia National Laboratories. The annual efficiency of such a system is in the range of 22-25%.

Stirling Energy Systems has announced two large power purchase agreements in California. The first is with Southern California Edison for the energy from a plant with 20,000 dishes producing 500 MW, with potential expansion to 850 MW. The second is with San Diego Gas and Electric for the energy from a 12,000-dish system producing 300 MW, with possible expansion to 36,000 dishes and 900 MW. With recent investment, the prognosis for successful deployment is very good.

Current efforts in dish-engine deployment center on cost reduction and large-scale manufacturing. The role of the national laboratories in this effort is in technology transfer and design support. In particular, as non-solar entities are engaged to provide manufactured parts and systems, Sandia's experience is leveraged to be sure that solar performance is not compromised. Additional development is centered on alternate engine advancement that could lead to lower operation and maintenance costs. The large number of dishes deployed in single locations help ramp up the production rates, which also leads to lower costs.

Power Towers

The power tower is also a point-focus technology that allows for higher temperatures than those in trough systems. In the tower system, a field of steerable mirrors reflects the sun's energy to a large point at the top of a tower, where a working fluid is heated and then either stored or directly used to drive a conventional turbine. A commercial power tower is likely to be sized in the range of 100 MW electrical output, although both smaller and larger plants have been proposed.

Tower systems can directly generate steam at the receiver location to drive a turbine. Such plants, on a 10 MW scale, have been demonstrated in Spain, where they have achieved annual efficiencies in the 12% range. A second approach is to heat a molten salt working fluid to a higher temperature, then store this hot salt until the generation of electricity is needed. A small-scale pilot plant, operated in the 1990s, demonstrated the feasibility of this approach. Larger molten salt plants are expected to lead to 18-20% annual efficiency. The higher temperatures of the tower systems make the possibility of thermal storage more economically feasible than with trough systems.

Although no US power tower plants are currently in production or deployment, several US companies have recently announced plans to pursue and develop various power tower technologies. Additional research and development will concentrate on cost reduction of the tracking mirror systems (development which is likely to support all the CSP technologies) and on the development of robust, efficient receiver assemblies.

Storage

Thermal storage of energy is unique to the CSP technologies, and it represents a significant advantage over other intermittent renewable technologies such as wind and photovoltaics. The large-scale storage of thermal energy is highly efficient, with over 98% recovery of stored energy. (Compare this to the battery storage of electricity, typically in the 60-70% range.) In addition, the storage containment equipment and fluids are quite cost effective compared to batteries, and they are more environmentally benign.

The thermal storage uncouples the collection and generation phases of the CSP cycle. Energy can be collected throughout the day, with actual generation of electricity deferred until needed (for example, evening peak periods). With enough storage, CSP technologies will be able to provide baseload (continuous, around-the-clock) power generation in the future. In the shorter term, storage can firm up capacity

during peak parts of the day as well as shift the generation to better match the utility's needs. Some utilities (for example, Arizona Public Service) have indicated they will not consider solar technologies without storage, as their peak period extends well into the evening. Other utilities do not see the need for storage in the immediate future, but begin to see the need as renewables reach toward 20% of the regional generating capacity. The use of substantial storage will allow CSP to provide greater than 20% penetration in the electric generation arena.

Trough and tower technologies are well suited to molten salt storage, a technology demonstrated in the 1990s on the Solar 2 pilot plant in Barstow, California at a 10 MW electric generation level. The demonstrated systems used a nitrate salt (which is essentially fertilizer) to collect and store the heat. Sandia National Laboratories is presently examining salts with the potential for a lower melting point (reduces parasitic loads and losses) and a higher operating temperature (improves total system efficiency). Sandia is also testing components and materials for durability in long-term exposure to the salt working fluids.

DEVELOPMENT NEEDS

The current public interest, high energy prices, and state renewable portfolio standards are driving unprecedented interest in CSP technologies. Deployment proposals and plans, as well as private investment in solar technologies, have grown exponentially over the past few years. More than 3000 MW of known Power Purchase Agreements (PPAs) are now on the books, with many more reported to be in progress. These deployments are investor-driven, so risk must be minimized to support return on investment. The national laboratories are continuing to play a key role in technology deployment and personnel training. The accumulated knowledge and experience in the laboratories is being leveraged through partnerships, Cooperative Research and Development Agreements (CRADAs), and other mechanisms. This leveraging helps the commercial sector deploy effective technologies and minimize the waste of capital investment. However, the laboratories also need to revive a research and development role that will develop next-generation systems with the potential to meet long-term cost targets.

Support and development needs lie in three key areas. First, continued technical support of near-term commercial deployments is needed to leverage the DOE investment in CSP development. Second, supply chain development is necessary to bring US industry capabilities to bear on this key strategic resource. Third, the laboratories must continue advanced development, leading the CSP technologies to more cost-effective solutions that bring us to mainstream power generation.

Industry technical support has been and continues to be the cornerstone of the laboratory involvement with CSP. Tools, methods, and technologies developed at the laboratories are directly responsible for the feasibility of the proposed deployments, as well as for ongoing improvements of operational systems in the field. The CSP personnel base at the laboratories has been very stable when compared to other missions of the laboratories, providing a continuity and experience base unmatched anywhere in the world. We have demonstrated an ability to provide significant value to industry partners during design, development, testing, and qualification phases of these technologies. However, there are limited "experts" in the solar field, so the rapid expansion of CSP firms has led to a severe shortage of engineers with solar experience. Working hand-in-hand with the laboratories has proven a viable method to add to the "solar expert" ranks. Sandia National Laboratories has also made use of its expertise in other areas of the laboratory, including manufacturing, failure analysis, materials research, Supervisory Control and Data Acquisition (SCADA) system and controls development, information security, and systems engineering. With the large planned deployments, this aspect of CSP development is reactive to industry needs.

Supply chain development provides for a transition of US manufacturing capabilities to these new technologies. The CSP technologies are presented to potential cross-cutting suppliers to develop a manufacturing resource for use across the CSP spectrum. This approach allows the leveraging of existing US nonsolar suppliers, particularly in the automotive sector, rather than reinventing the manufacturing wheel. This approach has proven successful in several areas for the Stirling Energy Systems team. The engine is being "productionized" by a Detroit engine production firm. Very significant enhancements have been proposed that will reduce the cost of the engine, increase reliability, and improve the performance potential. There are unique capabilities in American industry, developed for other sectors, which will impact all areas of the CSP designs. Supply chain development also includes development of solar engineers through development of university programs and curricula.

This aspect of CSP development must be cooperative with industry to leverage both laboratory and industry experience.

The laboratories must revitalize a thrust in advanced development for CSP technologies. Rapid deployment and substantial private investment make the CSP industry partners focused on near-term sales and deployments. Thus the laboratories must continue to develop next-generation systems, components, and tools. Industry is neither able to take on the risk of advanced development nor the distraction it would inject into the deployment process. Although industry has proposed approaches that will initiate large deployments, laboratory technology breakthroughs will lead to cost reductions that will make CSP technologies cost-competitive with conventional fossil-fuel power generation. The laboratories need to focus on development of disruptive technologies that will impact the cost and performance of CSP systems. Increases in system performance (efficiency) will directly impact electricity generation costs because the majority of the cost in these systems is in the collection apparatus (steel and glass). The laboratories must be proactive in the development of advanced technologies.

The laboratories have often developed new approaches that industry did not anticipate. These approaches often become part of the baseline technology that industry is prepared to deploy. Sandia has developed closed-loop tracking sensors and algorithms that substantially reduced the assembly accuracy requirements of dish systems. Rather than "perfect" installations, the closed-loop sensors and algorithms allow the system to learn and adapt to any imperfections, resulting in a substantial reduction in installation costs. Sandia-developed mirror facets have a substantially higher accuracy than prior "commercial grade" facets, and for about the same price. This development has changed the entire design paradigm for point-focus systems, as the improved performance has a substantial effect on the cost of electricity generated. These improvements are now entering the parabolic trough arena as well: Sandia-developed heat pipe receivers demonstrated a 20% improvement in system performance on one Dish-Stirling system. Further development is expected to bring this disruptive technology to the market. Systems models, tools, and development hardware have led to a better and more realistic understanding of system performance and costs. Spin-off technology and algorithms from Sandia's Advanced Dish Development System (ADDS) are being incorporated into the near-commercial products of Stirling Energy Systems, Infinia Corporation, and Eurodish. Sandia's new "TOP" (Theoretical Overlay Photographic) alignment system for troughs has demonstrated the benefit of optical alignment of existing trough plants, and it provides a tool to economically perform the alignment.

The high temperatures possible with the point focus systems (dishes and towers) make possible high-temperature chemical processes for the development of transportation fuels. Several processes have been proposed and are under development for splitting water using high-temperature processes, creating a reliable and cost-effective stream of hydrogen. Similar processes can be used to split CO_2 into CO and O_2. The CO can then be easily combined with hydrogen to create liquid fuels, which can then be distributed using the existing fuels infrastructure. The CO_2 could be supplied from sequestration at coal plants or, in the long run, through atmospheric scrubbing.

CSP MARKET POTENTIAL

CSP technologies are enjoying unprecedented interest and development, both in the US and worldwide. This interest is driven by a variety of factors creating something of a "perfect storm." Respected US and international companies are entering the CSP field, and significant private investment is flowing into CSP. In the US, there is significant solar resource in the Southwest states, primarily in areas with otherwise undesirable land.

Market Drivers

A variety of drivers have led to the current unprecedented commercial interest in CSP. The first is the Renewable Portfolio Standards (RPSs), primarily in the Southwest states, that mandate certain significant percentages of electricity generation must come from renewables. Although wind power has made significant deployments driven by the RPSs, utilities particularly like solar because of the match of the generation profile to the load profile. Therefore, as renewables have started to provide a notable fraction of the energy in some regions, the utilities have desired to balance wind generation with solar generation.

The second driver is the rapid and recent increases in fuel costs for conventional power generation. This factor is particularly applicable to natural gas plants, which were installed as "peakers" when natural gas was abundant and cheap just a few

years ago. Currently the costs of CSP generation are very competitive with peak natural gas generation, even at relatively small deployment levels.

Third, the cost of all energy, especially gasoline, has driven public sentiment and support for solar energy. Not only is solar seen as a stable, US-grown energy source, but it is also "green," satisfying additional public sentiment concerning global warming and greenhouse gasses. The extraordinary public interest is demonstrated to me each day as I field numerous calls from the media and private citizens.

Finally, the investment by DOE and private industry over the last 20-30 years has provided a level of technology readiness suitable for significant investment in large deployments. Although technical and financial risk is still apparent, the technical risk has been reduced through the laboratory and cooperative projects, demonstrations, and technology development. Modern design, manufacturing, and analysis tools applied to CSP allow rapid movement from concept to feasible hardware while reducing costs and risk.

Solar Resource

Presently, CSP technologies require approximately 6 acres per MW of installed capacity, compared to non-tracking PV at nearly twice that requirement. This translates to a 500 MW plant using about 5 square miles of desert land. CSP technologies require "direct normal insolation," which is a measure of the brightness of the light coming directly from the sun, rather then reflected off clouds and sky. Therefore, CSP technologies work best in clear, dry environments like the Southwest United States. Figure 1* shows the tremendous resource available in the southwest states of New Mexico, Arizona, California, and Nevada, with some areas in Colorado. Obviously not all of this land is available for CSP deployments.

An NREL study filtered this data to exclude land already in use, environmentally and culturally sensitive land, and land with significant slopes. The remaining lands were only considered when contiguous areas were greater than 10 km^2 (or 4 mi^2) and a solar resource over 6.75 $kwh/m^2/day$. Figure 2 shows the filtered data. If the minimum direct normal considered is 6.0 $kWh/m^2/day$, a still very good resource, considerable additional land becomes available, particularly in the State of Utah.

Although the vast majority of prime land has been filtered out, there are still more than 53,000 mi2 of land available for CSP projects. Table 1 shows a breakdown of potential land, filtered as noted, on a state-by-state basis. This analysis shows an available resource that is 7 times larger than the total nameplate generating capacity of the US electric grid. These data and maps are available from the Renewable Resources Data Center at NREL.

Table 1. CSP generating capacity by state on filtered land.

State	Land Area ($miles^2$)	Solar Capacity (MW)	Solar Generation Capacity (GWh)
AZ	19,279	2,467,663	5,836,517
CA	6,853	877,204	2,074,763
CO	2,124	271,903	643,105
NV	5,589	715,438	1,692,154
NM	15,156	1,939,970	4,588,417
TX	1,162	148,729	351,774
UT	3,564	456,147	1,078,879
Total	**53727**	**6,877,054**	**16,265,609**

CSP Cost

Renewable resources are best compared on the basis of "Levelized Energy Cost" (LEC). This is the present value of the total cost of building and operating a generating plant over its entire economic life, which is then spread across all the energy generated during the life of the plant, resulting in an average cost per kWh of energy produced in present-day dollars. CSP plants do not have ongoing fuel costs, which represent a significant fraction of the LEC of electricity from conventional fueled plants. However, the CSP plants are highly capital intensive, essentially buying 20-30 years of fuel up front in the form of collection equipment. Therefore, the LEC of CSP energy is highly dependent on financing and tax structures, as well as the rate of production of the equipment being fielded. The value of CSP is impacted by the cost, but also by environmental considerations that may or may not have a financial value, such as carbon footprint. Policies in this area can impact the value of CSP substantially. The cost of conventional generation is influenced by the current high cost of fuels, which also helps the relative value of CSP.

* Figures 1–4 have been retained in committee files.

Figure 3 shows the anticipated LEC reduction for CSP projects compared to the cumulative deployment of CSP projects. This projection is taken from the Western Governors' Association (WGA) Solar Task Force Summary Report of January 2006.[1] This model uses a trough plant with 6 hours of thermal storage as a surrogate for all CSP technologies, and includes continuation of the ITC. Significant reductions in cost are expected through manufacturing improvements resulting from the sheer volume of deployed concentrators. However, significant supporting policy and financial assumptions are included as noted in the figure.

Private industry is leading the way on current deployments. As expected, the exact terms of the contracts with the utilities are closely held secrets, so it is difficult to obtain accurate current costs of CSP generation. However, the 2003 Sergeant and Lundy report is an excellent resource on the prognosis for cost reduction of trough and tower systems.[2]

This report is scheduled to be updated to include modern technology improvements and financial considerations, and extended to include the dish-engine systems.

The current LEC for trough plants is estimated at $0.16/kWh. Industry experts have indicated that near-term deployments can be expected to produce an LEC in the $0.12/kWh range (DOE semi-annual review conference, Austin TX, April 2008). Further technological developments and very large deployments are needed to reach the predicted $0.06/kWh range. Several trough manufacturers have also indicated that the near-term deployments planned are highly dependent on a stable ITC policy.

The contract price for Stirling Energy Systems dish-system electricity is also a closely protected corporate secret. However, if one reviews current policy in California, it is clear that the base price for these near-term plants is likely at or below $0.10/kWh.[3] The high efficiency of the dish-engine technologies makes $0.06/kWh a feasible target. Again, the LEC is strongly impacted through large deployments leading to highly automated manufacturing. In addition, successful early deployments will lead to more favorable financing terms for later deployments, similar to the pattern seen in trough deployments.

No large tower projects in the US are far enough advanced to evaluate modern costs. However, the Sergeant and Lundy report indicates that towers can reach the range of $0.055/kWh. Towers have the inherent advantage of simple storage combined with higher temperatures than troughs, leading to higher efficiency and therefore lower cost.

The current energy environment is encouraging substantial interest in CSP. More than 3000 MW of deployment has been announced in the Southwest United States, and additional large deployments are in the planning and exploratory stages. Table 2 lists the publicly announced deployments planed for the Southwest US. In the near term, we expect an ITC extension would facilitate these deployments and accelerate the cumulative deployment of CSP in the United States.

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[1] Report available at: http://www.nrel.gov/csp/troughnet/pdfs/kearney__wga__overview.pdf.

[2] Sergeant and Lundy LLC Consulting Group, "Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts", Chicago, IL: NREL/SL-5641, October 2003.

[3] California CPUC Resolution E-4118 Adopting the 2007 MPR (Market Price Referent), 4 October 2007. Document available at: http://docs.cpuc.ca.gov/published/Final__resolution/73594.htm.

Table 2. Known planned deployments in the US as of Spring, 2008

Deployment	Size	Status
Trough/ORC in Arizona	1 MW	(APS Acciona, operating)
Trough electric project in Nevada	64 MW	(Nevada Power, Acciona, commissioned June 2007)
Dish-Stirling plant in Southern California	500 MW Option to 850 MW	(SCE, SES, Aug 2005)
Dish-Stirling plants in Southern California	300 MW Options to 900 MW	(SDG&E, SES, Sept 2005)
Trough plant	553 MW	(PG&E, Solel, July 2007)
Linear Fresnel Reflector	177 MW	(AUSRA, PG&E, Nov 2007)
Parabolic Trough with storage	280 MW	(Abengoa, APS, Feb 2008)
Arizona PS Consortium RFP	250 MW	(issued Dec 2007)
Parabolic Trough	250 MW	(FPL Energy, AFC filed)
Power Tower	900 MW	(BrightSource, PG&E, April 2008)
Other RFPs issued but not announced		
Total	**3,275-4,225**	

Figure 4 shows the expected impact of ITC extensions on the near-term deployment of CSP technologies, based on NREL projections published in the 2008-2012 Multi-Year Program Plan.[4] These plants take a number of years for design and development, permitting, and financing. Thus the importance of a stable, long-term taxation and credit policy cannot be stressed enough.

In summary, the cost of CSP is likely to be competitive with conventional generation processes. The cost reductions will come through a combination of technology improvement (performance improvement), design for manufacture (cost reduction through design), volume manufacturing (cost reduction through automation and stable factory orders), favorable financing (through investor confidence) and equitable taxation (recognition that the capital investment is comparable to fuel investment in a conventional plant). In the short term, the ITC will promote deployment to accomplish these cost reductions.

Market Barriers

While we enjoy an unprecedented renewal of interest in CSP, there remain several market barriers. If these barriers can be addressed, CSP deployments will accelerate more rapidly, moving the balance of our energy infrastructure toward a sustainable domestic resource.

The first barrier is financial risk. CSP plants are not consumer items; rather they are very large industrial complexes. The up-front cost is high, and it is paid back over long periods of successful operation. The lack of large deployments, particularly in dishes and towers, leads to uncertainty and therefore a higher cost for financing these projects. As plants are deployed, the financial risk is reduced, and the cost of financing is proportionally reduced. The current very high interest in troughs in part results from the ability to finance these projects based on the success of the over 400 MW in the Southwest United States. This is one area where the ITC can significantly reduce the cost of the plant to offset the high cost of financing due to the perceived risk.

Similarly, taxation policies impact the financial feasibility of CSP plants. The high amount of capitalization results in a significant tax burden when compared to conventional-fuel power plants. A state policy to exempt these plants from property taxes will help level the playing field, making CSP competitive with conventional technologies.

As we work with companies in planning large deployments, we find that available transmission capacity is a much larger consideration than land cost. Despite high public interest in renewable energy, the public tends to be very opposed to new transmission capacity. A good example is the Sunrise Powerlink, proposed by San Diego Gas and Electric. Current transmission capacity can handle the introduction of the 300 MW Stirling Energy Systems dish-engine power plant in the Imperial Valley. However, the proposed extensions will need the Sunrise Powerlink, which

[4] Department of Energy Solar Energy Technologies Program, Multi Year Program Plan, 2008-2012, April 2008. Plan available at: http://www1.eere.energy.gov/solar/pdfs/solar_program_mypp_2008-2012.pdf.

is currently opposed by several activist groups. Beyond California, if we anticipate the Southwest United States supplying CSP-generated power to large portions of the country, substantial changes to the nation's electrical grid will need to be considered. Any new large-scale transmission lines will also face challenges in ensuring minimal environmental impact.

Many of the proposed plants are on federal government land, primarily BLM land. The permitting process for these lands, though necessary to protect various national interests, is a cumbersome and slow process. The shear size of these plants, several square miles each, presents unique environmental approval challenges that must be considered in detail. Streamlined permitting and approval processes for lands in the "CSP hotspot" could accelerate development and deployment.

BLM recently announced a two-year freeze on new solar projects on BLM land while they study environmental impacts.[5] This freeze forces the consideration of environmental impacts to be performed in series with other site considerations, rather than in parallel, effectively delaying new installations by another two years. A coordinated federal streamlined permitting process could significantly shorten the process leading to deployment, rather than the current patchwork approval process that adds significant delays.

Beyond the land-use permitting, site development and planning takes years in order to meet many state and local requirements. The technologies are substantially different than conventional technologies from a utility perspective. This is particularly true with systems that do not incorporate storage. Large intermittent sources have not been previously addressed by the utilities, so there is substantial uncertainty. There are no applicable codes and interconnect standards for such systems. All these significant technical and policy issues slow the approval process and add financial uncertainty to the project developer. We need sustainable energy policies, economic conditions, and permitting processes that motivate private investment in new technology deployment.

CONCLUSIONS

CSP has the potential to meet a very large fraction of our nation's energy needs, starting with grid-based electricity and expanding to transportation fuels production. The resource available in the Southwest United States on easily useable land is nearly 7 TW, or 7 times the current electrical generation capacity of the US. Cost-effective and efficient storage sets CSP technologies apart from key intermittent renewables of photovoltaic solar and wind. This is especially important as intermittent renewables begin to generate significant fractions of our national energy supply.

CSP leverages existing US manufacturing capabilities. The fundamental building blocks of CSP are glass and steel, materials common to the automotive and building industries.

Current market drivers—including global climate change, high fuel prices, and technology readiness—have led to unprecedented interest in CSP technologies. A number of US and International companies are poised to deploy large CSP plants in the Southwest United States.

Significant deployment acceleration requires policy improvements, including a stable taxation and regulatory environment and streamlined land use and interconnect approvals and policies.

The support of the national laboratories has been crucial to the technical success of CSP projects, and the laboratories' role will not diminish with the advent of large deployments. The partnerships developed between the laboratories and industry have been extremely valuable in the feasibility and success of new CSP deployments. Although the technical support of the deployments is critical, the laboratories also need to promote supply chain development leading to cost reduction, and they need to enhance long-term research and development of disruptive and advanced technologies that will dramatically impact the cost and performance of future plants.

Continued industry support, supply chain development, advanced technology research, and stable policies will allow us as a nation to take advantage of this tremendous energy resource identified in our own backyard.

The CHAIRMAN. Thank you very much. Appreciate that.

Mr. Morse, go ahead and give us your view from Abengoa.

[5] Frosch, Dan. "Citing Need for Assessment, U.S. Freezes Solar Energy Projects," New York Times, 27 June 2008. http://www.nytimes.com/2008/06/27/us/27solar.html

STATEMENT OF FREDERICK H. MORSE, SENIOR ADVISOR, U.S. OPERATIONS, ABENGOA SOLAR, INC.

Mr. MORSE. Senators, thank you very much for inviting me to speak to you today on this very promising technology, CSP.

My company, Abengoa Solar, which has its U.S. headquarters in Denver, designs, builds, owns, and operates CSP plants around the world and would love to do the same in the United States.

As you mentioned, Americans are very concerned about their future. Energy prices are going up to unexpected levels, fears of recession, job losses, climate change issues. This CSP technology, as you have all acknowledged, is right in front of us, and it could be part of an energy, economic, and environmental solution. I think it should play a major role in our energy portfolio.

Charles mentioned what CSP is. I won't comment on that. But I will say it is bursting at the seams to come out on the Southwest utility market. Over a dozen companies are spending their own money to develop this technology without a Federal penny. Eight of them have signed contracts for over 4,500 megawatts, signed contracts. That could be instead of 4 to 6 coal plants or gas plants. These 4,500 megawatts could power over a million homes.

The utilities—and we just heard from PNM there, and we will hear from PG&E—they want to add CSP to their mix now, not tomorrow—now. The resource potential of the Southwest, your State and others, dwarfs the Pacific Northwest hydro resource. If it were oil, we would be racing to develop this. It can play a major role for the Southwest and the United States.

I can't resist. So I have to say there is one thing that stands in the way, and that is the immediate 8-year extension of the ITC. I will comment why. If that doesn't occur, New Mexico will lose. I think the facility that we heard about today will not get built. The Southwest will lose, and America definitely will lose. Without the 8-year extension, this industry will be stopped dead in its tracks.

With the extension of the ITC, I will state that there are no major barriers—there are problems—no major barriers for CSP to enter the utility market. Of course, there are other things the Federal Government can do—help with transmission, BLM we heard, siting issues, R&D support. Those are all in my written testimony.

The contracts signed to date, those 4,500 megawatts, are over $20 billion of investment. The investors are ready. They are ready to make the investment. But without the ITC, they cannot and they will not.

You asked about how long it takes to build a plant. I think building the plant, a year and a half is a good number. But permitting the plant could take another year or a year and a half. You have to win a contract with, say, PNM and negotiate that. You have to have a little pushing because the banks will say what happens on the day you start the plant up if the transformer blows and you need to buy another one? So that is the reason for the 8-year extension.

The economic benefits from unleashing CSP are impressive. Every dollar of tax credit will be multiplied many times by the investment to the $20 billion I mentioned—purchases from suppliers, wages from new jobs, and the flow through commerce associated. Those contracts on the books, none of which will happen—none of

them will happen. My company has one, and we can't get it financed without the ITC—is 25,000 construction jobs. The manufacturing jobs, like the Schott plant and others, will all happen with the ITC.

I am going to close with an example. We negotiated a project with Arizona Public Service for a 280-megawatt plant with 6 hours of storage. This plant will deliver energy well past sunset while the peak is still there. It will power 70,000 homes. It is carbon free. It is on figure 6 in my written testimony. APS sees this as the first of many. If they can't get this plant built, they will go back to natural gas, I predict.

So America has an enormous domestic resource. It is ours. It is carbon free, and it is forever. We have to develop it because it creates jobs that cannot ever be exported, and the resource adds security of supply with diversity and so on. But we are risking that.

So my last word is CSP industry is ready with its money. Wall Street is ready with its money. The States are ready with their subsidies. All that is missing, I am sorry to say, is the Federal extension of the ITC, and I hope maybe you two can find a way to work out a deal. But if not, the industry is going to be severely hurt.

Thank you very much.

[The prepared statement of Mr. Morse follows:]

PREPARED STATEMENT OF FREDERICK H. MORSE, SENIOR ADVISOR, U.S. OPERATIONS, ABENGOA SOLAR, INC.

Senators Bingaman, Domenici and Sanders, thank you for inviting me to speak to you today about one of America's most promising renewable energy technologies—Concentrating Solar Power, or CSP. My company, Abengoa Solar, develops, builds, owns and operates CSP plants around the world and is also planning trying to do this in the United States.

Americans are deeply concerned over their future, with oil and natural gas prices rising to unexpected levels, with fears of a recession and loss of jobs, with reports that the concentration of carbon dioxide in the atmosphere continues to increase, threatening many adverse consequences. Importantly, the EPA has identified electricity generation from fossil fuels as the single largest source of domestic CO_2 emissions.

But there is an exciting clean energy technology right in front of us that can become part of the solution to America's energy, economic and environmental challenges. The solution is Concentrating Solar Power and it can and should be a part of our national energy portfolio going forward.

CSP refers to a family of technologies that convert the sun's thermal energy into steam to generate electricity with zero carbon emissions. Some CSP technologies concentrate the sun and convert it directly into electricity via an engine or photovoltaics located at the focal point. Figure 1* shows the major CSP technologies.

CSP is most cost effective at utility scale (hundreds of MW) and some CSP technologies can provide electricity, on demand, when it is needed, and some can even produce electricity well into the night to meet summer peak demand. Some CSP technologies are commercially available and have been working reliably for over 20 years in the Mojave Desert, where they have not failed to meet a single hour of peak demand since they came on line—with the help of favorable tax policies. Figure 2 shows the output from a portion of the 354 MW CSP Plant.

It can be seen that when combined with natural gas to firm the output, these plants had an on-peak capacity factor of over 100% every year of their operation. Most current CSP plants now firm their output using thermal storage to become "pure" solar plants. Utilities are familiar with CSP and wish to add it to their energy mix. Not tomorrow, but today.

CSP is a power system straining to burst onto the southwest utility scene. Well over a dozen companies are developing CSP plants using private—not Federal—

* Figures 1–6 have been retained in committee files.

funds, and eight have signed contracts with utilities which total over 4,500 MW—equivalent to 4 large coal or natural gas plants that will not have to be built. These 4,500 MW of CSP plants will be able to power over one million homes. Because CSP has attributes that utilities prefer (generates steam, comes in large sizes and is dispatchable), more utility contracts are certain as the cost of CSP declines relative to fossil-fuel generation.

The solar-rich Southwest can look forward to the day when a solar-powered plant, not natural gas-fired or coal-fired generation, will be a utility's first choice—irrespective of whether or not renewable energy mandates exist. Because the CSP resource potential in the Southwest exceeds the hydro potential of the Pacific Northwest, CSP can become a major driver of the economy of southwestern U.S. and play a major role in meeting the region's future energy needs and environmental targets.

As the rays from the sun enter the earth's atmosphere, a portion are scattered and absorbed by the moisture and particulates in the atmosphere while some reach the surface directly. The unscattered portion is called Direct Normal Insolation. Because CSP technologies can only use the direct radiation, it is essential to know where the level of that radiation is highest as that will be the best place to locate a CSP plant, assuming the site meets other requirements. The National Renewable Energy Laboratory has, over the past years, used satellite date to map the solar resource in the United States. Figure 3 shows the distribution of Direct Normal Insolation in the southwestern U.S. The darker the color, the higher the solar radiation and the better for locating a CSP plant.

NREL then used GIS methodologies to filter out places where a CSP plant could or should not be sited, such as cities, waterways, environmentally sensitive areas, and mountains and slopes greater than 1 %. The resulting map is shown in Figure 4.

While most of the areas with high direct normal solar radiation have been removed, what remains are the "sweet spots" for CSP in the United States. The remaining areas represent the upper limit because additional environmental restrictions may exist or be placed on their use for CSP plants. Figure 5 shows the area and potential for CSP generation on the areas shown in Figure 4.

It can be seen that there is ample land and potential in the southwest to provide as much electricity as is needed and desired. And the technology to use this resource, CSP, exists and is poised to enter the utility market in large amounts.

However, one federal legislative action is essential if this new wave of solar power plants is to happen: the immediate 8 year extension of the 30% federal Investment Tax Credit or ITC. Without an 8 year extension, this rapid growth of Concentrating Solar Power will not occur and New Mexico loses, the southwest loses and America loses. Even the 4,500 MW of signed contracts will be voided since their pricing is contingent on the long-term availability of the ITC. Without an eight year extension of the ITC now, the CSP industry will be stopped dead in its tracks. Only the U.S. Congress can extend the ITC, and this is something that has proved surprisingly difficult.

Why must the ITC be extended now? Because during the time since the power purchase contracts for the 4,500MWs of CSP plants have been signed, the price of steel has increased dramatically and similar increases have been noted in the other commodities used for CSP plants. Until the ITC is passed, financing is not possible and therefore it is not possible to purchase the components needed to build the CSP plant. Furthermore, the financial markets continue to be troubled, making debt financing more difficult and costly. The longer CSP projects have to wait, the more difficult it will be to adhere to the terms of existing contracts and to finance these projects.

Aside from the extension of the ITC, there are no major barriers facing CSP. If the eight-year extension is enacted, CSP will burst onto the utility market. Of course there are other things that the Federal government could assist the CSP industry with. For example, the BLM should adopt a friendlier land policy for CSP, a process that is has begun, thanks to an impetus provided by EPAct.2005 The BLM is now identifying large tracks of federal land that are well suited for siting CSP plants and will perform generic environmental studies. This process needs to move along rapidly and with input from the CSP industry, and needs to be adequately supported by the Congress. The Federal government should provide stronger leadership in transmission, as the lack of new transmission lines is affecting needed electricity growth in many parts of the Nation. This same inattention affects concentrating solar power as prime CSP areas lack connection to the growing load centers in the southwest. Furthermore, the long time it takes to build such lines will limit the rate and extent of the growth of CSP in the market, underscoring the need for greater action in this area. Finally, the CSP R&D program at DOE has been under-

funded for many years and that needs to be corrected to support the innovation needed to help bring the cost of CSP electricity down.

The ITC could be thought of as a switch that if turned to ON and left ON for eight years, it will open the CSP market and trigger the building of CSP plants. The contracts signed to date with the utilities will require an investment of around $20 billion, all private sector dollars. And the investment community is ready to provide the needed debt and equity to finance CSP plants, but only if the ITC is extended for at least eight years.

The reason for the minimum of eight years is because of the long time it takes to complete the many essential steps to build a large power plant. These steps begin with finding and gaining control of a suitable site, obtaining regulatory approval on the power purchase agreement, completing the permitting process necessary to begin construction of the plant, building the plant and allowing some time for delays in any of these steps. This process is described in a presentation made at a briefing on 16 May 2008, at the request of Senator Sanders office.

CSP plants being bid today would be built in the 2012 and 2013 time period. If developers are to achieve cost reductions from 2 or 3 utility procurement cycles, only an eight year extension is effective.

The power point presentation titled "Why does it take so long to build a CSP plant" is attached to provide additional information on the steps and time needed to bring a CSP plant into commercial operation.*

The economic benefits from the unleashing of CSP are impressive. Every dollar of tax credit claimed by the ITC will be multiplied many times over in terms of the private capital investment, purchases from suppliers, wages for new jobs, and local and regional flow-through commerce. The job creation is significant. Approximately 25,000 construction jobs are associated with the 4,500 MW under contract. In addition, the building of new factories and assembly facilities for the main components will add more jobs and offer products for export to help our balance of trade. As natural gas is displaced by CSP, CO_2 emissions are reduced and, in time, its clean energy could be available for plug-in hybrid cars, thereby helping to reduce our dependence on foreign oil.

The following analyses provide additional details on the economic benefits form both CSP plants and related manufacturing:

- "Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California." April 2006 by L. Stoddard, J. Abiecunas, and R. O'Connell Black & Veatch
- "New Mexico Concentrating Solar Plant Feasibility Study." February 9, 2005 Prepared for the New Mexico Energy, Minerals and Natural Resources Department by the University of New Mexico Bureau of Business and Economic Research and Black and Veatch. The study may be found at: http://www.emnrd.state.nm.us/ECMD/RenewableEnergy/documents/NMCSPdraft-final-rpt-02-05. pdf
- "The Potential Economic Impact of Constructing and Operating Solar Power Generation Facilities in Nevada: Draft Preliminary Report." July 8, 2003 by R. Keith Schwer and Mary Riddel of the Center for Business and Economic Research University of Nevada, Las Vegas

I want to close with a specific example of CSP's potential:

> If the ITC is extended, Abengoa Solar will build the 280MW Solana CSP plant in Arizona that is now under contract. Under this contract, the energy will be sold to Arizona Public Service, powering over 70,000 homes with carbon-free energy. The schematic in Figure 6 below shows the Solana CSP plant. This plant will create 2,000 construction jobs and about 85 permanent jobs in a town with 68% of its population living below the poverty level. And this plant is likely to the first of many that APS will build to meet its growing demand for new electricity. However, Solana will not be built unless the ITC is extended soon. Instead, APS will likely turn to natural gas, adding to the climate change issues associated with fossil fuel generation. I attach for the record, a letter sent to Senator Cantwell, explaining why Solana can not be built unless the ITC is extended now.

American cannot afford to ignore one of its greatest domestic energy resources, especially if it is carbon free and can never be depleted. America cannot afford to ignore developing that energy resource, especially if it will create jobs that can not be exported. American cannot afford to ignore that resource, especially if it adds to

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* Presentation has been retained in committee files.

security of supply and to the reliability of its energy system. But we risk doing just that.

CSP developers are investing their money to develop CSP projects, Wall Street is ready to provide debt and equity, the states have invested in CSP with their incentives—the missing and critical investment is that of the federal government via the ITC. Please extend it now.

Thank you for your attention. I would be pleased to answer your questions.

ATTACHMENT.—LETTER TO SENATOR CANTWELL

APS,
ABENGOA SOLAR,
June 25, 2008.

Hon. MARIA CANTWELL,
511 Dirksen Senate Office Building, Washington, DC.

DEAR SENATOR CANTWELL, Thank you for your long standing support for the commercial solar power industry. Two months ago, you and Senator Ensign successfully amended the Senate's housing stimulus bill to include language that extended several alternative energy tax incentives, most notably I.R.C. Section 48's Investment Tax Credit for solar investment. The vote, 88-8, clearly demonstrated the support for incentives for alternative energy. Your strong leadership on this issue is greatly appreciated.

This letter is in response to your request for information from Abengoa Solar about the impact of the failure to enact an eight-year extension of the 30% investment tax credit (ITC) for solar property would have on the proposed Solana plant to be built near Gila Bend, Arizona. The Solana plant is a 280 MW Concentrating Solar Power (CSP) plant that is scheduled to be brought on-line in 2011. Abengoa Solar, Inc, a U.S. corporation, will own and operate this plant. It will require over $1 billion in capital investment, will create about 2,000 construction jobs and about 85 full time jobs to run the plant once it is built. In addition, if Solana were to be built, Abengoa Solar would also build an industrial mirror factory that would create some 150 jobs in the Southwest.

The output from this plant will be purchased by Arizona Public Service (APS) under a Purchase Power Agreement and will provide the new capacity needed to meet the state's growing demand and to respond to its requirements for clean energy generation. This plant will use thermal energy storage to allow the plant to continue operation for six hours after the sun has set, allowing APS to meet the summer cooling demand well into the evening hours.

Because the Solana plant is a partnership between APS and Abengoa Solar, both companies are responding to your request.

A long-term extension of the 30% solar ITC is needed to allow Abengoa Solar to provide the electricity at a price that APS is able to pay. If Congress fails to enact an 8-year extension of the ITC in the coming weeks, the simple answer is that banks and equity investors will be unable to provide financing for this plant and it will not be built. In the absence of a long-term extension of the ITC, APS would more than likely rely upon a natural gas fired plant to meet the demand that could otherwise be met with clean, solar power from Solana.

The delay and failure to pass the extension of the ITC has other consequences. Since the price for the electricity from the Solana Plant was fixed several months ago, the price of steel has increased by over 30%. As this plant will use as much steel as would be needed to build a second Golden Gate bridge, this also risks the economic viability of the plant. Further delay will only exacerbate this situation. To be very clear, if the ITC is not extended soon, the Solana project will not be built because the financing will not be there. The same fate is very likely for the almost 4,000 MW of other CSP plants with signed contracts, based on the availability of the 30% ITC. The total loss of investment is close to $20 billion and the loss in related jobs is well over 20,000.

Additionally, we need to be clear that the Solana plant is relatively far along in the development process and that many of the other proposed CSP plants that together represent our national hopes for utility-scale CSP are further back in the development process and will require the proposed eight years to qualify for the project financing.

We have followed each of the back and forth efforts by the House and the Senate to extend energy tax incentives. You know that the American public is watching this as the price of fossil fuel supplies continue to rise and they want to see a long-term national vision that will transition us towards sustainable clean energy. The failure of Congress to find a way to pass this extension is jeopardizing U.S. jobs and economic activity. We hope some compromise can be found that would allow this exten-

sion to pass very soon so Solana can be built and its benefits to the economy and environment can be realized.

Sincerely,

SANTIAGO SEAGE,
CEO, Abengoa Solar.

DON BRANDT,
CEO, Arizona Public Service.

The CHAIRMAN. Thank you very much.

Mr. Daly, go right ahead. Tell us Mesa del Sol's involvement in all of this.

STATEMENT OF MICHAEL DALY, MESA DEL SOL, ALBUQUERQUE, NM

Mr. DALY. Thank you, Mr. Chairman, Senators. It is an honor to be here today.

My name is Michael Daly. I am with Forest City, a national developer, and we are developing a project called Mesa del Sol. I am here really to speak on behalf of economic development primarily because I think we have got a good pulse on what is going on.

When we came to New Mexico about 3 or 4 years ago, our first job was to create high-paying jobs for New Mexicans. We wanted to build a sustainable community with some affordable housing and also concentrate on creating a community of continuing learning. We think the solar industry has created a unique opportunity here in New Mexico, which could be mirrored in other southwestern areas.

We started with a design. All of our buildings are LEED certified. We are doing Energy Star on the housing, and we are doing some unique water-harvesting ideas. But with the help of Sandia—and I look at my colleague Chuck, who taught us what concentrated solar was 3 years ago in his lab, and they have been a tremendous resource—we have gone further.

We are working with the labs on creating the first smart grid at Mesa del Sol, so houses can actually follow up or down their electricity depending upon time of day and peak generation needs. We are looking forward to having about a 40-house nanogrid at Mesa del Sol smart houses as a demonstration project. We have 38,000 houses we can leverage over time to roll on a very aggressive program.

We are also working with Bob Galvin and the labs on a perfect energy circuit at PNM and looking at transmission and how we run our switches to create a more efficient system. Now the base electric cost for Mesa del Sol is $180 million. It costs $280 million for the perfect system. It is not that we are going to spend the extra $100 million, but we can provide for the future, and PNM has been very helpful with that.

But probably most important, we have learned with the Sandia people and through the delegation as well as those in the State is that Mesa del Sol has an ideal site for a concentrating solar site, which we hope to respond to the upcoming PNM RFP.

That is actually controlled by DOE. It is a 1-by-5-mile buffer that we have been working with DOE and the base on, as adjacent to the base and part of the load center. So we will be responding to the concentrating solar RFP, hopefully with a development partner. We are talking to some today. We think it is terrific to have that

model project here in Albuquerque. It works economically, and it is the best site for PNM.

But on the economic development front, what we did 3 years ago when we came here is we started to canvass solar companies. We went to trade shows. We went to sites, and we really searched out—and my colleague Dr. Marker and I had dinner and a lunch in Colorado 3.5 years ago talking about Schott, which was really the beginning of that deal.

The solar industry is a terrific industry for jobs. They are high-paying jobs. New Mexico is well suited for it. They have got the university. They have got the labs, and there is a natural propensity to do that type of research.

I will say it started with Advent Solar, which the delegates were very helpful with, which we appreciate, which is up producing solar modules itself in an 87,000 square foot facility here. That is 300 jobs.

I want to take a moment to note that the biggest problem is solar engineers, and we are working with a project at UNM to try and get some engineering programs. Forest City has currently endowed a chair in digital and film media. We are going to endow a chair and work with Schott to create education programs for solar engineers. So I think that cornerstone of educating engineers to create the solar is really important so that my colleagues, for all of us to get the students to do this technology.

The Schott Glass was literally the shot heard around the world. After the Schott Glass deal, our inquiries from solar companies went from approximately 1 a month to 10 to 15 a month. It is interesting in terms of where the economy is, our inquiries and our canvassing relative to actual industries that are expanding has really compressed in the past 2 months, but the solar business is going crazy.

Mirror companies, receivership companies, balance assistance, photovoltaic companies are all looking in the Southwest and looking to expand. But a lot of them are hesitant to make major commitments. I am pleased Schott has made the commitment to make a plant until the ITC has passed.

So we are looking forward to continuing the economic development. We are looking forward to creating our cost. The Sandia lab is important, and university education is important.

Fred has mentioned some economics, but I just wanted to give you some broad-brush things. About 0.1 percent of our electric is generated by solar nationally today.

Senator DOMENICI. One tenth of 1 percent?

Mr. DALY. One tenth of 1 percent. So it is a relatively small amount of our power.

Senator DOMENICI. That is both the kind that we are talking about today and the other kind?

Mr. DALY. PV.

Senator DOMENICI. All kinds of solar?

Mr. DALY. All kinds of solar. So it is a miniscule amount. To the extent that we went to 2 percent of our power, or approximately 6,600 megawatts, which is close to what is on the books right now, we would create more than 1,000 permanent jobs, 25,000 construction jobs.

The real rollout that I find important is the Schott factory could generate enough receiverships for that, or Schott's competitors, that is another 1,400 permanents jobs. For the mirror company that has got to come here to do the manufacturing, that is another 1,400 jobs.

You know, with a multiplier effect, that winds up being 40,000 jobs that could be created by just doing this 5,000 megawatts of electricity, which is a tremendous economic boost not just in New Mexico, but nationally. There are photovoltaic companies in Vermont, in Boston, in Massachusetts, all over the United States that are waiting for this to expand.

The total construction dollars to create this 5,000 megawatts is about $40 billion in construction, which really would just multiply through our economy. That is a why we should do it from an economic development point of view. We would certainly be proud to have at Mesa del Sol a 600-acre concentrating solar plant that is located adjacent to the base of the research facility. We think it would be a tremendous coup as the radiation values are there.

What do we need to do? Everyone has talked about the ITC credit. I would like to mention something, which is a unique opportunity for DOE to get involved. DOE currently consumes 15 megawatts of electricity a day, has a 15-megawatt load here. But when you go to DOE, they are hamstrung, from a policy point of view, that they can't enter into a long-term power purchase agreement. So they, themselves, cannot enter into and facilitate a renewable power contract for 30 years because they are hamstrung with the current procurement rules.

Secondarily, their proxy for what they can purchase that power for is today's fuel prices with no adjustments into the future. So I find it an opportunity as much as a detriment to have DOE take a leadership role in here and perhaps in the energy bill create ways that the Federal Government, DOE, can be like the utility company and agree to pay a premium.

While the power is maybe priced at 6 or 7 cents a kilowatt hour now, perhaps it would have to be 13 or 14 cents a kilowatt hour, which is detrimental for the military budget. Whereas DOE, they are the model of—as we were saying, I think it would be good if they took it on themselves. The load is right here, and there is a possibility of them participating as well, as well as other major military installations in this solar belt.

Education. I think creating centers of excellence and getting funding for specific photovoltaic programs at our universities, our resource institutions is terrific.

Ultimately, I have to say, as a developer, as an entrepreneur who wants to see things happen, there is an instance—as Fred mentioned, there is a problem getting permitting. The DOE controls one of the many sites in New Mexico to make one of these solar facilities a reality. It would be a shame if DOE was actually the impediment in creating a longer schedule versus being the facilitator to make one of these things going.

I do want to say that I appreciate the delegation's offices. I have visited them several times. We wouldn't be as far in both education and knowing what we have to do, and some of these things are al-

ready in the works, but I wanted to say these are things that can really facilitate solar jobs, which is our main mission.

Thank you.

[The prepared statement of Mr. Daly follows:]

PREPARED STATEMENT OF MICHAEL DALY, MESA DEL SOL, ALBUQUERQUE, NM

MESA DEL SOL CONCENTRATED SOLAR PLANT

- Site control of a 1200 acre flat site adjacent to Mesa del Sol.
- With a 800 megawatt generation projected deficit, PNM has authorized a feasibility study which will examine the feasibility of building a concentrated solar plant in New Mexico by 2011.
- PNM has established a joint venture with EPRI to investigate developing a plant.
- Last year New Mexico State Legislature put in place significant incentives which will subsidize the cost of producing electricity via a concentrated solar trough plant.
- Sandia Labs is the leading concentrated solar trough research institution in the United States and is located immediately adjacent to the Mesa del Sol site.
- Mesa del Sol is part of the largest load center in the state and transmission to the grid is readily available on site.
- Schott Glass, as a new employer in New Mexico, is a leader in receiver tube technology
- Mesa Del Sol has Among the best solar Resources in the United States.
- The Mesa Del Sol project would have minimal Environmental Impacts
- Kirkland Air Force Base could buy green power from the plant.

The CHAIRMAN. Thank you very much.

Dr. Marker, tell us your perspective from Schott Solar.

STATEMENT OF ALEX MARKER, RESEARCH FELLOW, SCHOTT NORTH AMERICA, INC., ELMSFORD, NY

Mr. MARKER. Senators, thank you for the opportunity to speak with you today about concentrating solar power and the vital role CSP can play in securing America's energy independence, creating jobs right here in New Mexico, and how CSP can become an economic engine, driving sustainable growth.

In just 1 hour's time, the amount of energy that the Sun shines upon the Earth's surface exceeds the energy consumption of all mankind in an entire year. In the 5 minutes I will be speaking with you today, the Sun shining upon the United States alone contains enough energy to satisfy Americans' power demand for an entire month. Nowhere is that potential greater than right here in the desert Southwest and especially in New Mexico.

CSP is a proven technology. The SEGS plants in the Mojave Desert have been operating for more than 20 years providing 350 megawatts of power, generating clean electricity to hundreds of thousands of homes in California. Just last year, 6-megawatt Nevada Solar One facility went online producing clean electricity for Nevada.

There are plenty of high-value resources available right here in New Mexico for CSP generation. In fact, the entire State's electrical needs could be satisfied by the Sun. Energy can be even exported to other regions.

But all of this is at risk without a firm commitment from the Federal Government in the form of effective policy and long-term extension of the investment tax credit. The U.S. is a sleeping giant when it comes to solar energy. By extending the investment tax credit, this giant will awaken.

According to independent analysis, there are approximately 4,000 megawatts of CS power plants currently in planning or development stage. That is 4,000 megawatts that will most likely never be built without a long-term extension of the ITC. The industry needs the Federal Government's support to make CSP power generation competitive with that of traditional generation technology.

What does effective Federal policy translate to? For one thing, the increase in solar energy adoption means an increase in jobs. It is forecast that if the ITC is extended, 62,000 manufacturing and distribution jobs will be created in the solar industry directly as a result of increased adoption of renewable energy. Many of these jobs in the CSP arena.

On top of that, there will be an increased demand for electricians, plumbers, engineers, potentially thousands of new jobs created each year. This is job growth for Americans by Americans for an industry that will benefit America.

The company I represent, Schott Solar, is in the construction phase of a large manufacturing facility in Albuquerque. This plant will employ 1,500 people in the production of photovoltaics and receivers for the CSP power plants. Over the long term, Schott's investment in New Mexico will reach $500 million, and the economic impact is forecast to exceed $1 billion.

This is just what one company is doing in one community. There are other companies undertaking similar large projects from Michigan to Oregon and many more that are ready to do so once a clear commitment from the U.S. Government is established in the form of a long-term investment tax credit.

If the renewable energy tax credit expires, the impact next year will be more than 100,000 jobs either lost or not created, according to Navigant Consulting. Additionally, there will be more than $20 billion worth of investments that won't be made, and there is no doubt that this money and those jobs won't go overseas.

Renewable energy is domestic energy. Domestic energy not only means jobs for Americans, but it means reducing our greenhouse emissions. It is something Americans want. According to a recent poll, 94 percent of Americans say that it is important for the United States to develop and use solar energy. Almost 80 percent feel that the Federal Government should make development of solar energy a major priority through actions such as extending the ITC.

We have an opportunity today to address the challenge of global warming while growing our economy. All we need to do is harness the power of the Sun, and to do that, we need your support. Distinguished members of the Senate Energy and Natural Resources Committee, we sincerely thank you for your time and your consideration in this important matter.

[The prepared statement of Mr. Marker follows:]

PREPARED STATEMENT OF ALEX MARKER, RESEARCH FELLOW, SCHOTT NORTH AMERICA, INC., ELMSFORD, NY

SUMMARY

- Concentrated Solar Power (CSP) represents a proven and reliable technology.
- Solar energy is relevant for almost every country in the world, especially the United States, where conversion of only 2.5% of the nation's usable area into solar farms would satisfy the entire nation's energy needs.

- Investment in solar will lead to the creation of hundreds of thousands of jobs (UC Berkeley).
- Energy produced from the sun by CSP benefits from stability in costs, as there are no commodity priced raw material requirements for fuel, only minimal (3 cent kW/h) operating costs.
- By 2050, solar power could end U.S. dependence on foreign oil and slash greenhouse gas emissions (Scientific American).
- With the necessary investments, energy produced by the sun could become cost competitive with fossil-fuel based technologies by 2020 (NREL).
- The United States has the opportunity today to address the challenge of global warming while creating jobs and growing the economy.

A PROVEN RESOURCE WITH ALMOST LIMITLESS POTENTIAL

In just one hour's time, the amount of energy that the sun shines upon the earth's surface exceeds the energy consumption of all of mankind in an entire year. In the time it takes you to read this document, the sun shining upon the US alone contains enough energy to satisfy America's power demands for several months. Energy from the sun is an integral part of a renewable energy portfolio. A portfolio that would strengthen our nation's economy, secure our energy independence, and provide clean energy to meet the ever increasing demand.

That potential is greatest in the desert southwest, and especially New Mexico.

The idea of harnessing the power of the sun is not new. Documents dating back to Archimedes have shown theories on how this can be accomplished. Yet it hasn't been until recently that major strides have been made on mass-producing solar technology, and not until the last few years that technological innovations have been made to dramatically reduce costs.

CONCENTRATED SOLAR POWER

Concentrated Solar Power (CSP) plants are utility-scale power plants that generally produce greater than 50 MW of power, enough to supply the energy needs of thousands of homes. In one variation of CSP, called parabolic trough, hundreds of trough-shaped parabolic mirrors are continuously adjusted to face the sun. These parabolic mirrors concentrate the sun's thermal energy onto receivers, located along the mirrors' focal points.

The concentrated solar radiation increases the temperature of the thermo-oil Heat Transfer Fluid (HTF), flowing through the receivers, to approximately 750° F. This super-hot fluid is then used to turn water into steam, which drives a turbine, generating electricity. The capacity of these power plants is well suited for utility-scale power generation as the plant's peak efficiency matches peak demand requirements placed on the grid.

RELIABLE AND PROVEN CLEAN ELECTRICITY GENERATION

Over the decades, solar technologies have been reliably providing clean energy to tens of thousands of Americans. Photovoltaics have been in production for 50 years, and SEGS in the Mojave Desert, a CSP parabolic trough power plant, have been operating for more than 20 years, providing 350 mega watts of power per year. Just last year the Nevada Solar One facility went online producing 64 mega watts of clean power.

UNITED STATES—A "SLEEPING GIANT"

The U.S. has at least 250,000 square miles of land in the Southwest alone that are suitable for constructing solar power plants, and that land receives more than 4,500 quadrillion British Thermal Units (BTU) of solar radiation a year. Converting only 2.5% of that radiation into electricity would match the nation's total energy consumption in 2006.

According to the American Solar Energy Society: "Generation from CSP technologies, especially those that can be augmented with thermal storage or hybridized with natural gas, is well matched with southwest load profiles, which tend to peak in the late afternoon and early evening."

"States with suitably high solar radiation for CSP plants include Arizona, California, Colorado, Nevada, New Mexico, Texas and Utah. Even if we consider only the high-value resources, nearly 7,000 GW of solar generation capacity exist in the U.S. Southwest." (Jan. 2007)

According to independent analysis, resource calculations show that just seven states in the U.S. Southwest could provide more than 7 million MW of solar gener-

ating capacity—roughly 10 times the total U.S. generating capacity from all sources today.

The following chart shows available resources in the desert Southwest (considering grade of less than 1 degree, and other necessary land conditions.

State	Available Resource	Land Area (mi²)
New Mexico	1.6 TW	12,800
Arizona	742 GW	5,750
Nevada	619 GW	4,790
California	1.1 TW	9,157

Source: National Renewable Energy Laboratories (NREL), SunLab

The DESERTEC model, which has been developed to supply solar energy to Europe, provides a realistic model in exporting energy. In the Desertec model, energy would be generated in Northern Africa and Southern Spain and then shipped to Northern Europe. A similar model can be adapted and applied to the Southwest of the United States, where states like Nevada and New Mexico export solar energy to northern areas of the U.S. and Canada.

A key stumbling block in the US however, is in transmitting the energy produced in the Southwest to other regions. The need for a national "smart grid" is seen as essential in creating a network of energy produced by renewable energy. Even without the proliferation of renewables, many experts are in agreement that the nation must implement a "smart grid"—as evidenced by the California rolling black-outs, the NorthEastern blackout of 2004, and the South Florida blackout of 2008.

In a December, 2007 a report issued by Emerging Energy Research titled "Wind Power Strategies in the US 2007-2015" stated: "CSP production in the US and Spain expected to reach 7500MW by 2020 enough to power 6.75 million homes"

"CSP is the fastest growing utility-scale renewable energy alternative after wind power, with up to $20 billion expected to be invested in CSP over the next five years."

The long-term potential for solar technologies is even higher, as represented by the following chart (figure 2)* from the Solar Wirtschaft (Germany).

Advantages of solar energy production are numerous. In addition to no carbon emissions, harnessing the energy from the sun pulls energy from a never-ending resource. The costs are fixed, and energy prices remain stable as there is no reliance on a fossil fuel. Solar is a complimentary technology to other forms of renewable energy, such as wind and biomass.

MIDTERM: WHAT DOES IT TAKE TO MAKE CSP COST COMPETITIVE

Many view solar technology to be cost-prohibitive, while this was true 20, even 10 years ago, thanks to innovations and improvements in efficiency from industry, the cost per kW/h is steadily decreasing. It is only through continued government support however, that the industry will continue to make investments in research and development, which will further reduce costs and bring them in line with electricity generation from traditional fossil-fuels.

A chart (figure 3) for CSP technologies again shows parity within the next decade with key productivity sources in economy of scale, increase of efficiency and the development of storage technologies. Funding is again assumed for eight years through the extension of the ITC.

Currently in the United States power from renewable energy sources accounts for less than 6.5% of the US energy consumption, of which solar is 1 %. However the US is showing one of the biggest growth rates with CAGR (compounded annual growth rate) of 36% from 2006—2011.

In a conservative market scenario, the overall US PV market will reach ~900 MW in 2012. Through an aggressive market scenario, the US market can more than triple, to almost 3GW of installed capacity by 2012. The aggressive scenario assumes a long-term (8 year) extension of the investment tax credit. This extension will allow for sustained manufacturing capacity expansion, as evidenced by companies like SCHOTT, who is investing $500 Million in a solar technology production facility in Albuquerque, NM. Strong demand growth must continue with minor supply excesses causing large price declines in line with unit subsidy rate declines. The 3GW market in the US compares to a 7.6GW world market.

* All figures have been retained in committee files.

ENERGY COST STABILITY

With oil prices currently exceeding $140/barrel (6/30/08), and energy prices correlating with the price of oil, the need for fixed-price energy solutions is more important than ever. Solar represents fixed cost power generation. With more widespread deployment of CSP, through economies of scale and technological improvements, the costs of CSP power generation will continue to decrease. Currently, the cost to operate a CSP power plant is approximately 3 cents per kilowatt hour (not including the cost of amortizing the construction of the facility).

The following chart (figure 4)—labeled Exhibit 1-1, shows CSP deployment as it relates to the cost of natural gas.

EFFECTIVE LEGISLATION WILL PUSH CSP DEVELOPMENT

Investment tax credit

There are key steps the Federal government can take to create a favorable climate for the deployment of CSP. First and foremost, a long-term renewal of the Federal Investment tax credit (ITC) is seen as an essential first step. Although the overall cost of the ITC extension is variable based on the amount of solar actually installed, independent analysis (GE Capital) has stated that the solar component (including PV) will most likely not exceed 2 billion USD over the 8 years. When compared with the job creation and the billions of dollars in investment by private industry, the payback on the 2 billion should not be difficult to recoup.

The following chart (Figure 5), labeled exhibit 1-16, shows how the ITC, along with other (global) legislation will spur development and deployment of CSP.

Federal Renewable Portfolio Standard (RPS)

Many states, including New Mexico, have enacted Renewable Portfolio Standards (RPS') which state that by a certain time, a certain percentage of electricity either generated—or consumed—in a State must come from renewable sources. Some even go further down by mandating a renewable mix where a certain percentage must come from solar. The Federal government could enact similar legislation, which would signal to the CSP industry a clear commitment, which would enable long-term investment. As a comparison, states with RPS' currently have 80% of the renewable energy projects in the pipeline compared to 20% of non RPS states (according to EER).

Feed in Tariffs (FIT)

A current stumbling block for the development of CSP is in negotiating power purchase agreements (PPA's) with utilities, who buy the renewable energy and then distribute it to customers. The FIT model, originally developed in the US, and successful deployed in both Germany and Spain (see case-study following) would create a Federal incentive to purchase energy from renewable sources. Since CSP is a utility-scale generator, this would ease the constraints of the utilities who are under pressure to deliver power to the end customer at competitive rates, but also are obligated, in many areas to purchase energy from renewable sources (from the RPS).

A national FIT is seen as one of the most effective means of rapidly growing the renewable energy market in the US.

Easing Land Management Restrictions

There is a current moratorium placed on new solar projects on Federal lands as the environmental impact of CSP power plants is currently being studied. While the industry understands and recognizes the importance of such studies, stopping all projects while commissioning an environmental impact studies is perhaps too far reaching. A compromise should be developed that strikes a balance between renewable energy and stewardship for the environment.

Transmission

Since CSP is currently not installed on a widespread basis, and the energy produced is therefore consumed in local regions—due to the extraordinary potential of the technology, a time will come when transmitting the energy to other regions will become necessary. In this regard, the Federal government can support utilities in creating a "smart grid" that will enable such transmission over the network of utility owned transmission lines.

NATIONAL, BI-PARTISAN SUPPORT FOR SOLAR

A recent (June, 2008) study conducted by the independent polling firm Kelton Research, demonstrated the tremendous support solar energy has across America. 94% of Americans, representing individuals across all political affiliations and geographic

regions, support the development and use of solar power. Additionally, approximately 75% of Americans support the extension of the ITC and almost 80% feel that solar should be a "major priority" of the Federal government. When asked which one energy source they would develop if they were president, most respondents chose solar over any other type of energy generation.

TECHNOLOGICAL BREAKTHROUGHS ON THE HORIZON

When speaking about electricity generation, you're speaking in costs. The cheaper the generation, the more widespread it will become. Critics of solar state that the energy produced is not cost-competitive with current methods, and it only works during the day.

Through support from the Federal government, private industry, will most likely overcome key technical hurdles in the technology, which will further reduce costs. Currently, the Heat Transfer Fluid (HTF) breaks down if it exceeds approximately 750 degrees Fahrenheit. If a suitable replacement can be developed the potential exists to heat the fluid to higher temperatures, improving the efficiency.

Additionally, in Spain, the first CSP plants that utilize molten salt storage units are currently being deployed. By storing the heat generated during the day, CSP plants could become a 24/7 operation without the need of a natural gas feed backup.

Other advancements in the technology can be made through advanced coatings on the receivers, lighter and cheaper materials used in construction of the parabolic trough mirrors, and other areas of the power blocks. These advancements can be made if the CSP industry knows that a market will exist to deploy and utilize the technology that can be developed.

CASE STUDY: A MODEL FOR ECONOMIC DEVELOPMENT—SPAIN

After an early start as a world leader in solar energy, the United States lags behind several countries in both solar energy development and deployment. However, global warming and rising prices for fossil fuel are causing the United States to consider how it can regain world leadership in the generation of solar energy. Overseas best practices offer proven models for how the U.S. can increase solar energy production. One of the leading examples may be found in Spain, where the government has undertaken aggressive initiatives that have made that country one of the world's solar power leaders. Not only have these initiatives helped increase the amount of solar energy generated in the country, but they have spurred the development of Spain's solar power industry as well proving to be an economic stimulus and creating jobs.

There are some obvious reasons for Spain's leadership in solar power. For one thing, solar energy generation is simply the exploitation of one of the country's most abundant natural resources. As British and Scandinavian sun worshippers can attest, Spain enjoys more sunlight than any country in Europe. Yet, in many ways, this resource remained untapped until 2004, when the Spanish government issued Royal Decree 436, which made sweeping reforms to solar energy policy, creating a new system for renewable energy development and deployment, with its own regulatory framework.

The decree ended a regime of small steps toward promoting the use of solar power and instead initiated the adoption of bold policies that would strongly encourage the deployment of solar energy. These policies included grid connection and tariff reform, promotion of large-scale concentrated solar power (CSP) plants and later, solar panel mandates for new and renovated buildings. Their initial goal was ambitious—30 percent of the nation's electricity to be supplied by renewable energy sources by 2010.

GRID CONNECTION

Grid-connection is critical to the development of renewable energy anywhere. In Britain, for example, the Labour government refuses to remove obstacles to grid-connection, and solar energy development lags. Without some form of guaranteed grid access, it is difficult for companies other than the grid owners to develop large-scale solar power plants, severely limiting the number of companies who can enter the market.

In 2004, the Spanish government removed the economic barriers to grid-connection for renewable energy sources. With this single measure, large-scale solar power plants were guaranteed access to the electricity grid and a market was created for the solar energy generated at these plants.

ECONOMIC INCENTIVES

Spain has made economic incentives, particularly feed-in tariffs, a key feature of its solar energy program. In 2002, Spain became the first European country to adopt a feed-in tariff of 12 euro cents for every kilowatt-hour supplied to the grid. In order to further accelerate the development of solar power the government passed a decree in 2004 that almost doubled the feed-in tariff for solar energy kilowatt hours, to 23 euro cents, and guaranteed these rates for 25 years. Instantly, large-scale photovoltaic and CSP generation were transformed into profitable business propositions as the 23 euro cents per KWh tariff was made specifically applicable to 100 KW to 50 MW plants. To keep the ball rolling, in 2007, the subsidies were raised yet again to 27 euro cents per KWh.

When combined with grid connectivity, these economic incentives made the development of solar energy in Spain practical. Planning and construction of solar generating plants in Spain accelerated, creating jobs and stimulating the economy.

LARGE SCALE CSP

Though CSP is less well known than PV, since the 1980s CSP plants have reliably and cost-effectively generated large amounts of clean energy in California's Mojave Desert. Recognizing the tremendous potential that CSP offers geographic areas located in the world's sunbelt, Spanish policy essentially makes CSP fully equal to PV technology. With large areas that receive strong amounts of direct sunlight, Spain is very well suited for the development of CSP plants.

At the end of this year Spain plans to start operation of its first commercial CSP plants. The first plant, Andasol 1, will be the first commercial parabolic trough CSP plant in Europe. It will have a half-million square meter collector field and will be capable of supplying electricity to as many as 50,000 homes. This plant is the world's first to include thermal storage technologies that allow the plant to produce power at night. It does this by storing up to seven hours of energy in hot molten salt reservoirs. The heat in these reservoirs can be tapped to generate electricity after the sun goes down. Ultimately, this technology could enable solar plants to operate around the clock.

The Andasol plants are only the beginning. As of early 2008, five other Spanish CSP projects were underway, with a total expected capacity of 190 MW. Spain's tremendous CSP potential recently led my company, SCHOTT, to invest approximately $28 million in a new parabolic trough CSP receiver production facility in Spain.

SOLAR MANDATES FOR NEW AND RENOVATED BUILDINGS

In addition to opening up the grid, providing aggressive tariffs to solar power generators and encouraging the development of both PV and large-scale CSP, Spain has undertaken another step towards a solar energy future. A new policy, introduced in 2006, mandates that all new and renovated buildings include either solar water heating systems or PV arrays. New homes must have solar heating systems capable of providing from 30 to 70 percent of their hot water, with the specific requirements to be determined by the building's location and expected water usage. These panels will not generate electricity, but they will help cut the demand for electrical power significantly. For non-residential buildings, such as hospitals and shopping malls, the standard is different. They are required to have PV panels that generate a portion of their electricity. The Environmental and Housing Ministries expect these mandates to bring energy savings of 30 to 40 percent for each building, and reduce carbon dioxide emissions by 40 to 55 percent.

In 2004 the Spanish government set a goal of 400 installed MW of PV and 500 MW of CSP by 2010. Currently, it seems likely that Spain will easily exceed these goals before 2010. By 2007, about 600 total MW of solar generating capacity were installed, with more projects under construction and scheduled for completion in 2008 and 2009. In fact, four of the 13 largest PV power plants in the world are in Spain. Two plants in Jumilla and Beneixama each produce 20 MW and each deploys more than 100,000 PV panels. The two other plants are a 13.8 MW facility in Salamanca and a 12.7 MW operation in Lobosilla.

LESSONS FOR THE UNITED STATES

The Spanish experience offers important lessons for the United States, and especially the American Southwest, given that its climate is similar to that of Spain. The first and most important lesson is that without bold long-term policies, solar energy generation will only grow in fits and starts. Unfortunately, U.S. federal solar energy policy legislation has been short-term, with incentives periodically allowed to lapse, providing developers with no certainty that these incentives will be re-

newed or changed. This deters investment, and does not persuade the public that Congress and the Administration are serious about renewable energy policy.

Solar power plants—like any power plants—are major commitments, expected to be operational for at least 30 years. These kinds of investments require long-term federal energy policies.

For example, the U.S. tax credit now applies to a range of renewable energy projects and affords a 1.9¢ per kilowatt-hour benefit for the first 10 years of operation for a renewable-energy facility. It also lapses at the end of 2008. So projects—solar, wind and other renewables—languish while their developers await Congressional action.

The U.S. could benefit from adopting other aspects of Spain's solar energy policy. If the U.S. instituted a national grid connection policy, developers would be better able to overcome the obstacles inherent to a federal system with multiple jurisdictions. Currently, these bureaucratic roadblocks slow down or completely stall the development of many large-scale solar energy projects. In addition, the U.S. could further spur solar energy development by mandating the installation of solar energy in residential or commercial buildings.

The United States, and especially its desert Southwest, possesses great potential for rapid solar expansion if policies akin to those of Spain are adopted. Many government officials, utility executives and citizens in the American Southwest already recognize this, and are taking action to develop the region's abundant solar resources, despite federal inaction. The Western Governors Association has set an ambitious goal of generating no less than 8,000 solar MW by 2015, and has recommended many regulatory and other public policy changes to promote solar and other renewable energy development. Early this year, Arizona Public Service announced plans to build the 280 MW Solana Generating Station near Phoenix.

Another lesson the U.S. can learn from Spain is that strong support for solar power provides many economic benefits. For instance, Spain's Ministry of Industry estimates that the solar and other renewable energy industries will create 200,000 new jobs by 2010.

The United States has found itself behind in the deployment of important technologies before, and found ways to catch up and secure world leadership. However, if our country adopts renewable energy policies similar to Spain, we can catch up just as we did with other technologies. And catching up will not just help the U.S. move beyond the use of fossil fuels and reduce its greenhouse gas emissions. Despite not having solar energy policies as aggressive as Spain's, the Solar Energy Industries Association (SEIA) estimates that 314 megawatts of new solar were installed in the U.S. in 2007, contributing $2 billion to the U.S. economy and creating 6,000 new jobs.

SOLAR ENERGY AS AN ECONOMIC ENGINE

Solar energy is domestic energy. The economic engine created by a powerful solar energy policy is multi-faceted. The most powerful component of the strengthening in the economy is in job creation. The University of California Berkley estimates "green jobs" will reach one million in the United States by 2020. These are high-wage manufacturing and professional jobs. In addition, there are a host of associated industries, such as plumbers and electricians that will also benefit.

It's forecasted that if the ITC is extended, 62,000 manufacturing and distribution jobs will be created—directly as a result of increased adoption of renewable energy in the first year of the extension.

This is job growth for Americans, by Americans, for an industry that will benefit America.

In addition to job creation, there are other economic benefits. Consumers will be able to combat volatile energy prices. Utilities will finally have a power infrastructure that can meet peak demand. Distributed solar can stabilize grids and offset expensive infrastructure upgrades. By 2020, the cost of generating solar power is forecast to become cost -competitive with fossil fuel energy production.

As an example, SCHOTT Solar, the company I represent, is in the construction phase of a large manufacturing facility in Albuquerque, NM. This plant will employ 1,500 people in the production of photovoltaics and receivers for CSP power plants. Over the long-term SCHOTT's investment in New Mexico will reach $500 million and the economic impact is forecast to exceed $1 Billion. But this growth will only happen if effective legislation is passed.

That's just what one company is doing in one community. There are other companies undertaking similar large projects, and many more that are ready to do so, once a clear commitment from the US government is established in the form of a long-term Investment tax credit. If the renewable energy credits expire, the impact

next year would be more than 116,000 jobs either lost or not created according to SEIA and Navigant Consulting. Additionally, there will be more than $20 billion worth of investments that won't be made. And no doubt that that money, and those jobs, would go overseas. Considering the current economic climate of the country, these job losses, and investments moving overseas would be detrimental to the overall health of the nation's economy.

SOLAR AS A COMPONENT OF NATIONAL SECURITY

Currently the United States is reliant upon politically unstable regions of the world for much of its energy. According to the Energy Information Agency, two-thirds of the petroleum and 20% of the natural gas consumed in the United States is imported from other countries, and U.S. production of both is dropping while consumption continues to rise.

By installing solar powered power plants and the necessary infrastructure to transmit energy across the nation, states in the desert southwest could become an exporter of energy, helping economies in the region grow. Increasing energy consumption from renewable energy will stabilize energy costs and minimize wild fluctuations on the economy caused by volatile energy prices.

According to a study published in Scientific American (January, 2008) by 2050, solar power could end U.S. dependence on foreign oil and slash greenhouse gas emissions.

With sun shining all across the world, every country can develop solar energy as a means to create energy independence. Already, through solar, rural villages in South East Asia are benefiting from having electricity for the first time. Solar is scalable and deployable.

SUMMARY AND RECOMMENDATIONS

Renewable energy, specifically solar, represents tremendous potential for the United States. Through effective legislation, the United States can develop an industry with proven successes in Germany, Japan, and Spain. An industry that has the potential to create up to a million jobs domestically, reduce the country's dependence on foreign energy supplies, improve the environment for future generations.

- With the eight year extension of the Investment tax credit (ITC), an additional 62,000 jobs will be created. Up to a million will be clean-energy employed in the sector by 2020 according to UC Berkeley.
- By fostering developing of renewable energy, and specifically solar, costs will become competitive with fossil fuel based technologies by 2020.
- With the development of a National grid connection policy, solar project developers would be better able to overcome the obstacles inherent to a federal system with multiple jurisdictions. Currently, these bureaucratic roadblocks slow down or completely stall the development of many large-scale solar energy projects.
- With multiple GW of installed solar capacity, the US will be reducing its growing dependence on foreign energy source, which often come from politically unstable regions of the world.
- Strong support for solar will enable the industry to continue to make technological advances, including thermal storage, which extends the operating hours of solar power plants beyond daylight hours.
- CSP is a proven, reliable technology with a tremendous potential.

[Appendix documents have been retained in committee files.]

The CHAIRMAN. Thank you very much.

Mr. Wan, representing Pacific Gas & Electric, thank you for coming, and we look forward to your testimony.

STATEMENT OF FONG WAN, VICE PRESIDENT, ENERGY PROCUREMENT, PACIFIC GAS & ELECTRIC COMPANY, SAN FRANCISCO, CA

Mr. WAN. Senators, thank you for the opportunity to be here today and for this committee's leadership and commitment to advancing a clean energy future for the Nation.

My name is Fong Wan. As part of my role as Vice President of Energy Procurement at PG&E, I have the responsibility for overseeing the purchases of renewable energy.

PG&E has a long and accomplished track record on clean energy. We have contracted with about 40 renewable suppliers in the last 5 years. We are one of the Nation's largest buyers of renewable energy. Due to the large economy we serve, which is about 1 out of every 20 Americans, we have been fortunate to have the opportunity to meet with developers and technologies from all over the world.

We are committed to expanding our renewable supplies on an unprecedented basis. This includes a very sizable commitment to CSP. We have already contracted with four large solar thermal suppliers of various technologies that we can get into later. This amounts to about 1,700 megawatts. When these resources come online, they will represent enough power to meet almost 10 percent of our peak summer needs.

Moreover, we have stated a strong desire to pursuing even more opportunities in this area. That is because of this energy-producing availability at a time when our customers need it most and its relative cost effectiveness compared with many other renewable options. You have to take into consideration the time of the generation of CSP as well as theoretical potential. By National Renewable Energy Labs' estimate, CSP could, in theory, produce 7 times the energy needed to serve California.

I also want to provide our latest observation on photovoltaics. PV are making a strong and great progress for utility-scale applications. We also hope to be in a position to announce several contracts for utility-scale PV applications as well.

But given these advantages, it is reasonable to ask why the Nation is not seeing greater progress on renewables. As someone with daily experience in today's renewable energy marketplace, I would like to point out a few barriers. It is important to underscore that the Federal Government is uniquely positioned to help the country push past these obstacles.

The first is economics. Despite falling costs, CSP cannot yet compete on price with electricity produced by natural gas. We are confident that will change as the economies of scale are achieved and technology is refined. But in the interim, Federal production and investment tax credits are absolutely essential for continued progress.

Past experience shows a smart use of tax incentives makes tremendous difference in the pace and extended innovation and deployment of new renewable projects. The Federal Government should extend the PTC and ITC. It should also remove the ITC exclusion for regulating utilities. Utilities represent a significant source of potential new cost-effective capital investment. We should remove this handicap that effectively sidelines well-capitalized, motivated investors.

The lifetime of the extension is also critical. We believe the minimum commitment should be 8 years, as you have heard earlier. An 8-year extension would send a critical market signal. It would provide the assurance investors need to spur long-term R&D and allow the transmission to be built for large-scale CSP projects.

Without a longer term extension, we are deeply worried that developers will slam on the breaks and projects will be delayed, stopped, or prices will increase by as much as 30 percent to our customers. We, therefore, urge Congress to take action as soon as possible on the legislation it has before it.

Another significant challenge in bringing renewables online faster is transmission. Without new lines, we cannot get power from remote locations to the customer. Yet siting new transmission has become extraordinarily difficult. Mr. Chairman, you were exactly right when you recently said we need to be sure that first rules for planning, siting, pricing, interconnection, and openness of access are adequate.

Right now, it is not uncommon for a project to be stopped by a single stakeholder, and actions by some Federal agencies can also have major ramifications. We support BLM's desire for a comprehensive approach to solar projects in the Mojave Desert and throughout the West. We also appreciate BLM's commitment to continue to process those applications which already have been accepted. However, we hope that future CSP projects are not further complicated by the deferral on new applications.

A third challenge is integrating these intermittent renewable resources into our overall supply. One key is developing storage technology. We applaud Congress for including energy storage R&D program in legislation this year.

To summarize, in this time of high energy prices, a weak economy, and heightened focus on security, the Federal Government is uniquely positioned to provide clarity of vision and foster stable growth in this critical sector of the energy market. We encourage policymakers to address the challenges outlined, and we look forward to working with you to do so.

Thank you very much.

[The prepared statement of Mr. Wan follows:]

PREPARED STATEMENT OF FONG WAN, VICE PRESIDENT, ENERGY PROCUREMENT, PACIFIC GAS & ELECTRIC COMPANY, SAN FRANCISCO, CA

Chairman Bingaman, Ranking Member Domenici, and Members of the Committee, I am very pleased to appear before you this morning on behalf of Pacific Gas and Electric Company to offer my views on the important role of concentrated solar power (CSP) as a clean, renewable source of energy. My name is Fong Wan and as part of my role as Vice President of Energy Procurement for PG&E, I have the responsibility for overseeing all of our renewable power procurement. At a time of historically high energy prices, increasing concerns over climate change and U.S. energy security, I commend the Committee for its leadership in addressing this important topic and for the continued commitment to and support for alternative energy that Chairman Bingaman, Ranking Member Domenici and others on this Committee have demonstrated over the years. The Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007 have both helped to advance alternative energy, improve the overall energy efficiency of our economy and begin to dismantle barriers to ushering in a new energy paradigm for the 21st century.

Pacific Gas and Electric Company, headquartered in San Francisco, California, is one of the largest natural gas and electric power utility companies in the United States. The company provides natural gas and electric service to approximately 15 million people throughout a 70,000-square-mile service area in northern and central California. PG&E proudly delivers some of the nation's cleanest energy to our customers. On average, more than half of the electricity we deliver to customers comes from sources that emit no carbon dioxide, or CO_2, and an increasing amount comes

from renewable sources of energy. In 2007, approximately 12 percent of our electric delivery mix was comprised of California-eligible renewable resources.[1]

PG&E is actively pursuing renewable generation resources on behalf of our customers for several reasons, including the following: first, it is what our customers consistently tell us they want; second, it furthers our efforts to meet the California renewable portfolio standard, which requires that 20 percent of our electric power be derived from renewable energy sources by 2010, a policy goal that PG&E strongly supports; and third, it allows us to better manage our future cost risk, on behalf of customers and shareholders, by taking volatile and rising fuel prices out of the cost equation for this portion of our generation.

PG&E has announced several contracts with wind, geothermal, biogas and solar developers. Solar thermal energy, the subject of today's hearing, is an especially attractive renewable power source because it is available when power is needed most in California—during the peak mid-day summer period. PG&E has entered into four solar thermal power procurement contracts totaling up to 1,737 megawatts of power, enough capacity to supply almost 10 percent of our peak summer needs. These include a contract with Ausra for a 177-megawatt facility in San Louis Obispo County, CA, a contract with Solel for a 553 megawatt facility in San Bernardino County, CA, and a contract with Brightsource Energy for 500 megawatts from facilities in San Bernardino County with an option for another 400 megawatts.[2]

We believe the potential for solar thermal technology, as well as other solar power technologies, is significant—and we are not alone. For example, a study prepared by the National Renewable Energy Laboratory (NREL) on the potential for concentrated solar power, or CSP, in California and the rest of the Southwest U.S. indicated that CSP in California could produce upwards of seven times the energy needed to serve the state. NREL also suggests that costs for CSP technologies could decline significantly, from approximately 16 cents per kilowatt-hour on average today, to approximately 8 cents per kilowatt-hour in 2015. The halving of the cost of this energy in seven years is premised on an assumption that at least 4,000 MW of CSP will be built by then—not just contracted for—to achieve "learning curve" benefits. For a comparison to another major energy technology development effort, cost estimates for advanced coal power generation with carbon capture and storage are on the order of 11 cents per kilowatt-hour.

We are also impressed by the progress being made in reducing the cost of photovoltaic technology and look forward to a healthy competition between CSP and utility-scale photovoltaics to meet the peak electric needs of California customers. We expect to announce a number of large, utility-scale photovoltaic projects in the near future. We think the competition between the two solar technologies will help our customers over time by bringing the cost of solar energy down.

As we move forward aggressively to deploy these renewable, clean, domestic energy resources, we recognize that challenges remain to fully realizing their potential in California, and across the nation. I will use the balance of my remarks to outline some of the challenges we see.

A. Extension of Incentives is Essential

As noted, while the cost of solar is anticipated to decline over time, competitive electric power pricing is perhaps the biggest current obstacle to more rapid and widespread deployment of solar and other renewables. Still a nascent industry in the U.S., solar has yet to reach economies-of-scale that will bring down the per-unit production cost to levels competitive with natural gas-fired plants.

One of the most important tools needed until the prices become competitive is the Investment Tax Credit (ITC). As a major buyer of renewable energy, Pacific Gas and Electric Co. is concerned that without proper tax incentives, there will be a significant slowdown in the development and construction of solar and other new renewable energy projects and technologies going forward, making it extremely difficult to meet the economies-of-scale required to drive down cost. An example of this phenomenon can be seen in the wind technology development experience. The expiration of the Production Tax Credit (PTC) in 2004, which is a key incentive for wind power projects, caused a 77 percent drop in installed wind capacity that year relative to one year prior, 2003. By comparison, in 2007, with the PTC in

[1] As defined in Senate Bill 1078, which created California's renewable portfolio standard, an eligible renewable resource includes geothermal facilities, hydroelectric facilities with a capacity rating of 30 MW or less, biomass, selected municipal solid waste facilities, solar facilities and wind facilities.

[2] The fourth contract is with San Joaquin Solar for 106.8 MW in Fresno County, CA.

place, the wind industry enjoyed its best year ever when developers installed more than 5,000 megawatts of new generating capacity, more than twice the previous record. The ITC is expected to have a similar effect on the solar industry. The tremendous spurt of innovation, development and associated economic activity we have seen with solar, and in the renewable energy sector generally, could be squelched if these tax credits are not extended. Needless to say, the loss of this economic activity would occur just when the national economy, buffeted by the housing collapse and record energy prices, needs all the support it can get.

The federal government can therefore make a tremendous contribution by extending the ITC and PTC, as proposed in H.R. 6049, and removing the regulated utility exclusion associated with the ITC, as regulated utilities are in a position to provide financing for these capital-intensive projects. We believe the 8-year extension for the ITC included in the recent Senate package is the minimum amount of time necessary to reduce financial uncertainty, spur longer-term technology development and encourage fuller deployment of these projects. Given the long investment lead-times for CSP, an extension of 8 years would send a critical signal to investors to commit to these projects. In the absence of a long-term extension of the ITC, we are very concerned that the projects currently under development may be delayed, stopped, or priced in a way that will raise costs to electricity consumers by up to 30 percent. We therefore urge Congress to pass the provisions contained in H.R. 6049 as soon as possible, so that the solar and other renewable industries can have the certainty they need to make investments, create jobs, and make a positive contribution to meeting the nation's energy needs in an environmentally-sound and sustainable manner.

B. The Transmission Challenge

Another significant challenge we face in bringing renewable energy resources online faster is transmission. In California, for example, most large-scale concentrated solar power generating facilities are sited in remote desert locations, far away from the areas where the electricity is needed most. While siting in these areas may avoid some, but not all, issues associated with major power plant project siting, if we can't get the power to the customer, it's just a different kind of stranded asset. In fact, Senate Majority Leader Reid noted in his statement on June 17th before this Committee that the West alone will need approximately 7,500 miles of new transmission lines over the next decade to significantly expand renewable energy production.

Transmission siting is a multi-stakeholder process that is increasingly complicated in the case of interstate lines, due to multi-state regulatory requirements, myriad diverse stakeholder interests, and a lack of deference to a lead federal agency. It is not uncommon for a company to be far into the siting process and have a single stakeholder raise an objection which can stop the project's momentum 'in its tracks.' And actions by some federal resource agencies can also have major ramifications. We support the Bureau of Land Management's (BLM) desire for a comprehensive approach to solar projects in the Mojave Desert region and the west, and we appreciate BLM's commitment to continue to process those applications which have already been accepted. However, we hope that future CSP projects are not further complicated by the moratorium on new applications."

Mr. Chairman, I couldn't agree more with your statement at the June 17th Committee when you said, "[t]o get transmission built to carry renewable electricity, it's important to make sure that the transmission system in general is working well. We need to be sure that FERC's rules for planning, siting, pricing, interconnection and openness of access are adequate."

C. Integrating Intermittent Power Supplies

A third challenge we face is the ability to integrate an increasing amount of intermittent power resources into our generation portfolio. Solar is much easier to accommodate than wind in this regard, but it still poses challenges. A solution to this challenge lies in the ability ultimately to store excess power from these power projects, so that it is available when the project is not producing power—for example, on cloudy days or at night—and thereby smooth out the 'ups and downs' that are otherwise associated with intermittent power generation. Congress showed great foresight by including a thermal energy storage research and development program in Section 602 of The Energy Independence and Security Act of 2007, and

hopefully this program will lead to improvements in the cost and effectiveness of such technologies.

THE PATH FORWARD

At PG&E, we are working cooperatively with policymakers, regulators, others in our industry and myriad stakeholders to help tackle these challenges. For example, California's utilities are working closely with state and federal agencies on the Renewable Energy Transmission Initiative to identify areas that will require transmission investments to bring on new solar and other renewable energy supplies. We are working in a broad coalition, consisting of more than 300 organizations to help support and advance the energy tax provisions contained in H.R. 6049. We are working to identify and support emerging renewable technologies, like CSP, biogas, and wave technology, to help bring down costs and integrate these technologies into the electric power and natural gas systems. And, we are investing more than a billion dollars in advanced meters to upgrade our electric grid to make it a dynamic, "smart" system that will allow us to optimize its performance and better integrate these new, clean technologies, including advanced transportation technologies like plug-in electric vehicles.

In these uncertain times of rising energy prices, a weakening economy, and increasing national security risks from dependence on foreign oil, the federal government is well positioned to bring certainty to the energy market through sound policies that send the right long term signals that will spur the innovation, development, and deployment of renewable, clean, domestic energy resources that are so desperately needed. The opportunity to expand the renewable power industry can only be accomplished by addressing the challenges facing it in an integrated, strategic fashion that blends incentives, standards, public sector investment, and other key mechanisms such as a price and market for carbon, a major step that will allow renewables to compete against the real costs of conventional sources of electric power generation.

On behalf of PG&E, I want to thank you for the opportunity to appear before the Committee today and I look forward to answering your questions. Thank you.

The CHAIRMAN. Thank you all very much for the good testimony.

Let me just start and ask a few questions, and then we will sort of take 5-minute rounds here and go back and forth on questions.

One issue that I am not real clear in my mind on is how you accomplish the storage requirement that we are all talking about here. I think, Mr. Morse, you said that the proposal or the project that you are doing with Arizona Public Service involves 6 hours of storage. I think that is what Mr. Nelson indicated they would like to see as well.

I don't know if you would like to explain how that storage is accomplished, or Mr. Andraka, if you would like to explain it? One of you who understands a little more of the technology involved, I would be anxious to hear it.

Mr. MORSE. Let me take a stab at it. Imagine that you like coffee and you want coffee in your office at night, and you can't boil the water in your office. So what do you do? You boil more water in the daytime. You put it in a thermos, and you use it at night.

A CSP plant has an oil that runs through the plant that gets heated up to 700, 750 degrees Fahrenheit, and that hot oil makes the steam that runs the generator. If you expand the size of the solar field, then some of that collected energy goes not to make steam and run the plant in the daytime, but it goes into large, very large tanks of a fluid that has the heat capacity that can hold that high temperature.

Then at night, when the Sun goes down, you just run that fluid through a steam generator, make steam and run the power plant. So it is basically two large thermos bottles, one with hot oil that then runs and makes steam and then is collected in another tank, which is then heated up the next day.

The CHAIRMAN. Very good. This will allow you to extend the production of electricity for about 6 hours after the Sun goes down?

Mr. MORSE. Correct. You could do it for 8 hours or 10 hours. You could run it around the clock. It is all the economics of the utility's needs. But it is feasible to make CSP a base load option if the economics made sense.

The CHAIRMAN. I think one of you indicated that by putting this additional storage capacity in, you do bring down the cost of the electricity per kilowatt hour. Is that the expectation?

Mr. NELSON. Yes, sir. We believe, based on the EPRI study, that the inclusion of storage has the opportunity to reduce the overall cost of the process. In addition to helping us address peak load needs in the evening, there is also some opportunities to allow that plant to startup earlier in the morning.

So, for instance, if you were hitting a winter peak early in the morning, that plant could be up and running and generating electricity even before the Sun generates enough heat to generate electricity. So it serves a couple of our needs in terms of peak load.

The CHAIRMAN. OK. Yes, go ahead.

Mr. ANDRAKA. Senator, the labs are also working on advanced storage technologies. The technology that Dr. Morse talked about where you heat the oil and that, in turn, heats the storage fluid, we would like to extend that where you can directly heat the storage fluid in the field.

The issue there is the storage fluid right now freezes at about 200 degrees C. We have got new formulations we are working on that will stay liquid to a lower temperature so you don't have freeze issues in the field.

Mostly, we talked about trough systems today. An advanced technology is a tower system, where you are directly heating the salt in the receiver at a central point rather than throughout the field. So it gets rid of this distribution problem. We see storage as an inherent solution in towers as well as troughs.

One of the issues that also has to be addressed with storage is the contracts with the utilities that, in some cases, are regulated by the State that pay a certain amount at time of day. The storage increases the value of the electricity for the utility when they need it, but they need to be able to pass that value to the provider since we are looking at independent providers.

The CHAIRMAN. OK, let me ask one other question that is a little different from that.

Mike, you were talking there about—or maybe you weren't discussing it, but my understanding is that you are working on trying to develop an agreement with Kirtland Air Force Base on a power purchase agreement, something that would use power that might be produced at Mesa del Sol. Could you explain how that would work, how it would fit into the various other things we are talking about today?

Mr. DALY. Mr. Chairman, currently it is my belief that the base provides power to its tenants, which includes Sandia Labs, and that base negotiates a multi-year contract with WAPA, who acts as agent throughout, and both provide renewable power as well as traditional power on the wholesale market.

That contract might be—it is difficult to say what the renewable would be, but was 6 cents a kilowatt hour. It might be 7 or 8 cents going forward because of the increases. If DOE, as a tenant, decided that they wanted to take a portion of their load, 30 or 40 megawatts out of the total of 50 with the military being the balance, they are constricted for two reasons.

The first reason is they can't enter into a contract by law for more than 5 or possibly 10—there has been a recent event. It might be 10 years now power purchase agreement.

The second is that the proxy or the pricing under the OMB is that they have to match the lowest bid. Concentrated solar will never be the lowest bid today. But over that 30-year period if you have an extension of the power purchase agreement, or even 10, if you took into consideration an increase projected of fossil fuel cost, then they would be able to enter into that contract.

So there is a real OMB constraint and a contractual constraint preventing the biggest proponent of concentrated solar from actually being a buyer of concentrated solar for their own needs. This base and possibly other military installations have unique loads that really don't go down at night, too.

So we have actually worked a little bit on trying to straighten this out as a long-term possibility for DOE. But now that PNM has gotten the bulk of their requirement with the other utilities to 111 to 120 megawatts, we have a big enough plant. The original thought was that PNM's requirement wasn't big enough, and we would marry the DOE requirement and the PNM requirement to get the plant big enough because you have to do at least 120 megawatts.

I think long term it is both a policy and an opportunity. It is a great opportunity beyond having an additional generator backing up the entire installation here, which you could throw a switch and say they get the power first.

The CHAIRMAN. OK. Senator Domenici, go right ahead.

Senator DOMENICI. Mr. Chairman, I want to tell you I don't know how long you intend to continue, but I have no objection to your continuing if I am absent. I can't be here beyond 11:30. So that is 10 minutes, and you understand why. It has to do with my being present tomorrow.

Let me say that I have the cost of electricity by source per kilowatt hour, and I just want to make it a part of the record so it will be without a doubt.

We are getting there in terms of the solar we are talking about, the solar CSP. Obviously, we have got a ways to go, but I believe we will become more and more competitive if we get this—we can break it loose where it is not such an isolated job, but rather a contemplated and well-organized part of every utility that contemplates expanding so that they look at this first.

Not mandatory because we don't want to do that. But they look at it, and it is doable when we haven't put obstructions in. So I would like that to be in there.

Second, I did want to call to your attention, Mr. Chairman and this group of witnesses and our visiting Senator, the Albuquerque Journal seems to have gotten the understanding on what is going on. They have written about three editorials here in a row that im-

pressed me with their understanding of the problem we have with crude oil dependency, which is slightly different than most people understand.

You know, we can't get out of oil for a long time because we can't get rid of our cars and our trucks. We are going to try, but that dependency is going to be there for a long time just because of the transportation and transportation users in place. You couldn't load up all the cars and put them out in the ocean on barges and ship them out, then we would leave an America that was dead on its toes.

It may be 30 or 40 years until dependence. That is terrible. I must say that every hearing I am going to be at, I am going to talk about a completely different view of our crude oil dependency. I think it is destruction we are talking about. It is destroying the economy—look—$500 billion a year to other countries for our crude oil is not an issue of, "Well, it is not too bad." The point of it is the whole economy is suffering, and we don't quite know why, and that is it.

The reason our economy is in terrible shape is because of this. We are sending too much of our lucre, too much of our would-be equity, too much of our money to others just for this one thing.

Now, what I am concerned about, Mr. Chairman, and you are going to be there a long time to try to organize, I think we have a lot of institutions in this country that aren't onboard as partners in trying to get where we ought to go.

For instance, there is a lead editorial here, "Killing Energy Options Will Leave Us In The Dark." It is about a $400 million investment that was going to take place of the kind you were talking about, Mr. Daly. It was going to be made in California, and it is about to die because the transmission line to make it operational is 23 miles long and must cross a State park.

There was a group who loves the State park so much that they have killed the project by saying you can't cross our park. We all are environmentalists. Maybe you on the record more than I. You more, but we all are.

But we have to have the environmentalists join up, too. They have to be concerned about the problems we are concerned about. This plant in this editorial must proceed. I am going to bring it up and have our committee find out why we stopped a $400 million solar plant with a 2-mile transmission line.

I don't see how that could hurt a State park unless there was a big cable right over a picnic area. You know, this is a big park. So, I just want to make that case and put that in the record, Mr. Chairman.

The CHAIRMAN. We will be glad to have all of that in the record.

Senator DOMENICI. Second, I would like for you all to know that the Bureau of Land Management is called a lot of things, and they are unable to do a lot of things we all want them to do. In this case, they are in the midst of a real argument, and we have to help them, I think.

They need some policy advice. They are left there with hundreds of applications, and they don't have a lot of help because they are not used to 100, 200 applications for a great big solar plant on BLM land. We don't want them to be the killer, right? We want

them to be facilitators. But we have got to find out how they can help.

Did any of you run into this, just specifically, the BLM problem? Or is—yes?

Mr. MORSE. I could make one comment that I think is relevant and that is causing a lot of the problems. There are three types of projects. There are real projects, a signed power purchase agreement with a commercial operation date—2012, 2011. Those plants have to be built, and if they want BLM land, their applications should be considered immediately.

Then there are projects that are maybe. Somebody applies for land for something that is still in their mind. They don't have a power purchase agreement. That is a real problem because you can fill up the queue with that.

Then there are the speculators. Let us just be honest about it. There are people with money who say that land is going to be worth something, I will put in an application. It is like grazing land without a cow. I think those are parts of the problem, and I think BLM overreacted.

Senator DOMENICI. OK. Let me just say I have been informed, and that is what this whispering was, they have changed their policy. So, maybe we had an impact and maybe we didn't. Your concern on the BLM is no longer there——

Senator SANDERS. Do I understand that you are just telling us that they have lifted? They are not going to pose a moratorium. All right. We have some good news, good news.

Senator DOMENICI. That is good news, and I don't know how they are going to handle the vote. But anyway, I am grateful and that is nice that you called this meeting. That probably caused it.

[Laughter.]

Senator DOMENICI. My last point, Dr. Marker, I have never had a chance to thank you for your decision to come here. We are really glad to have you.

We hope that we have put in place the policies that will make your business thrive because that will be good for the country. In this case, we have got a winner. You win. The country wins. We win. So let us hope it happens.

But I would say to my friend, the chairman, there is probably not any better testimony than yours and yours, Mr. Daly—Marker and Daly—to support the proposition for the tax credit that we are looking for, that we want an 8-year extension. It is not the tax credit. What is it called? The investment tax credit.

There is probably not a better record than yours that clearly states that we don't have to worry about paying for this ITC. It is more than paying itself with growth that you are talking about.

Now I know my friend, Senator Bingaman, who I have great respect for his understanding and rationale, and he will answer that we are going in debt and how much more can we put on our grandchildren? I know all about that. I did that budget for 28 years for the Senate, and I did two of those balanced budgets, you know?

But, look, the point is we already have a policy of some sorts that will put this tax in place without an offset because it pays for itself. Look, you are telling us in your testimony that that is really true.

Anyway, I want to put this editorial in the record to remind us that transportation issues are important, and I want to close by saying to all of you we put into national law, you know, this business that I told you about in my opening remarks when you run into a wall, you pull it, take it away from the group that is arguing. You take it up with the secretary, and he sends it over to the commission, and they decide. We are catching all kinds of flak that we shouldn't be infringing upon these rights.

I want to tell you that that galls me. When I read in this Journal editorial that you are holding up a $400 million project in the State of California because an environmental group won't allow a 23-mile pipeline, I think the environmentalists have to join us. We need them.

But anyway, I think this hearing ought to be one that ends up saying right away this is very important, and we urge Americans to act like Americans on some of these issues and get rid of the parochialism of their cause and let it get in there and get solved, or the same thing is going to happen with nuclear.

I don't know if you are for it or not, but Senator Bingaman, at least he and I put in place what nuclear needs, just like we put in place what you need. Nuclear is going to come forward, and it is going to run into just what you are saying. We don't have enough trained people. We don't have enough engineers.

I never heard of solar engineers. But if that is a new doctorate or you have one? That is you?

[Laughter.]

Mr. ANDRAKA. There is one.

Senator DOMENICI. One. Where did you get trained?

Mr. ANDRAKA. Virginia Tech.

Senator DOMENICI. Virginia Tech. Do they give you a degree in solar?

Mr. ANDRAKA. Mechanical.

Senator DOMENICI. Oh.

Mr. ANDRAKA. I have become a solar engineer.

Senator DOMENICI. You can become that from mechanical. OK, well, that is what you are urging. You are going to get a seat in mechanical. How much does it cost to put one of those chairs in?

Mr. DALY. Too much.

[Laughter.]

Senator DOMENICI. I don't know. You are making a lot of money. You have got the best land deal anybody ever got.

[Laughter.]

Senator DOMENICI. I mean, I know your chairman. What is his name?

Mr. DALY. My chairman is Albert Ratner.

Senator DOMENICI. Yes, he is great. Whenever you worry about me not being on your side, you send him over.

Mr. DALY. I do. I do.

Senator DOMENICI. He is terrific. He is terrific. I understand him when he says he knows how to invest, and let him do that and we do some other things. I am all for it.

Mr. DALY. Thank you, Senator.

Senator DOMENICI. Anyway, you have got to be in this business—if you are going to run that big piece of land, you have got to be urging that people join together, right?

Mr. DALY. Correct, Senator.

Senator DOMENICI. Get some of their concerns, private concerns to join the cause.

Mr. DALY. Correct. I think the point there is no one person that can solve this. It is a collaborative effort with the utility, the States, and also the PRC has got some things they have to do to really allow us to do this.

Also the consumers have to recognize that green is going to cost them a little bit, too. It might be 25 cents a month on their electric bill, but we have got to get over that and go forward with it.

Senator DOMENICI. With that, Senator, Mr. Chairman, I am going to leave. I will let all these wonderful New Mexicans and you solve the rest of the problem.

The CHAIRMAN. Senator Sanders and I will solve the problem and report back to you.

[Laughter.]

Senator DOMENICI. You won't even need anything from me. Get it done.

The CHAIRMAN. All right. OK. Thanks for being here.

Bernie, why don't you go ahead with your questions?

Senator SANDERS. OK. First of all, it is, in fact, very good news, I think, to hear from the BLM that they have withdrawn their proposal to establish a moratorium on new applications. Maybe it is coincidental that it may have something to do with this hearing, but we are delighted that that is the result.

But one point that I want to make, and I want to ask the panelists about that, is while we are delighted with the BLM's decision today, what I hear is that they have just a very few staff people who are trying to process these claims.

So all of you are talking about the need to reverse global warming, to create hundreds of thousands of new jobs, to make ourselves energy independent, and every one of you is saying that concentrated solar is going to be an important part of that process, and we have a bottleneck with two guys who are sitting there trying to process all of these applications.

So I am going to ask you a rather silly question, but do you think we should substantially increase the staffing at BLM so that they can process these applications in a far more vigorous way?

Mr. Morse, do you want to start on that one?

Mr. MORSE. Of course.

Senator SANDERS. Mr. Wan.

Mr. WAN. Absolutely.

Senator SANDERS. You agree. Dr. Marker, do you agree with that? All right. OK.

One of the concerns that we have, and maybe one of you may want to go into it, I believe there are 130 applications in the pipeline. My understanding, and correct me if I am wrong, is not one of them has been approved yet. Is that——

Mr. MORSE. That is what my understand is.

Senator SANDERS. OK. So all of you are in agreement that we should substantially increase the staffing at the BLM to process these things.

Mr. MORSE. I would also add I think that it is a complex issue. There are land management plans that have to be revised.

I will say that BLM is being very positive. They are trying to identify zones in the West that are ideal for solar energy. They are working with the environmentalists to make sure there are no wildlife corridors. They are going to do a programmatic environmental impact study. So they are trying to do the right thing, but they are understaffed. Certainly, more people would help, and they probably could use some other policy support along the way.

Senator SANDERS. Mr. Chairman, the other question that I wanted to explore is the comparative cost of solar. By the way, yesterday I was in Nevada, and it is very hot in Nevada. You know that. I am from Vermont. I didn't know that. But 110 degrees is very hot.

[Laughter.]

The CHAIRMAN. That is why we are in New Mexico.

Senator SANDERS. You are right. I know that you have been talking, Mr. Daly, about working with your local base here. I was at Nellis Air Force Base, and I want to say that they have installed in a very rapid time, in about a 6-month period, not a concentrated solar plant, but it is the largest photovoltaic in the world.

It came in on budget. I think they did it in 6 months' time. It is producing more electricity than they anticipated. It is going quite well, and they have the capacity to produce even more. It was very nice to see a very positive relationship between the Air Force and the private sector and the environmental community. That is a very good omen, I think, for the military in general.

Let me quote—well, not quote, but my understanding, Mr. Andraka, is that according to a 2008 Sandia National Labs presentation, our costs for concentrated solar are projected to drop to 8 to 10 cents per kilowatt hour when capacity exceeds 3,000 megawatts. Is that your understanding?

Mr. ANDRAKA. Yes, that is correct. That is based on a study done for the Western Governors Association, which also goes back to the Sergeant and Lundy report. DOE right now is funding an update to that Sergeant and Lundy report that will include dishes and update the cost estimates for troughs and towers.

Senator SANDERS. Now tell me what I am missing here, but that sounds to me to be pretty reasonably priced electricity. The other point is that if you look at it over a 25-year period, it is not going to go up a whole lot, we don't think—unless Exxon buys the Sun or something.

[Laughter.]

Senator SANDERS. That it is not going to go up too much. Is that right?

Mr. ANDRAKA. The cost in a given plant will only go up with the labor——

Senator SANDERS. Right.

Mr. ANDRAKA [continuing]. Once the plant is put in place. Obviously, the plant depends on the cost of commodities, such as glass——

Senator SANDERS. But my point is, and I think PG&E—and we talked about that as well, with Mr. Darby to help us, is that if you look at 8 to 10 cents a kilowatt hour, and you sign a 25-year purchase agreement, 25 years later, 10 or 11, whatever it may be, that is going to be pretty cheap electricity.

Am I missing something, or is that correct, Mr. Andraka?

Mr. ANDRAKA. That is correct. Usually these contracts will have some inflation escalator built in, but we see the cost of natural gas going up a lot more rapidly.

Now in the last decade or so, the cost of natural gas was seen as cheap as far as we could see it, and that has been one of the impediments to rolling out——

Senator SANDERS. Right. But compared to the volatility of gas or oil, the Sun is going to be reasonably stable?

Mr. ANDRAKA. Yes. Yes.

Senator SANDERS. Mr. Wan.

Mr. WAN. I think I would like to offer that even with conventional power plants, as they are facing the increased costs, there are still cost of raw materials, of the concrete. The conventional power plants are facing an increase of roughly 20 percent in cost. I would expect renewable generation, including CSP, to be facing that type of cost pressure.

Senator SANDERS. For construction?

Mr. WAN. For construction, absolutely. That is without the impact of natural gas prices. Once it is in, it is minimal replacements on the mirrors as well as the tubes, and you are absolutely right.

Senator SANDERS. Maybe Mr. Morse or anybody else would want to comment? I mean, there are a lot of things and you have said it all about why we should be moving forward in an aggressive manner for concentrated solar. But cost may, in years to come, be one of the reasons. It may be a very competitive product.

Mr. Morse.

Mr. MORSE. In fact, Arizona Public Service, when asked why are they spending a little more for CSP today, the answer was it is a fixed price. It will never rise. They have no idea what natural gas will cost next year, 5 years, 10 years, if we will be able to burn it. It is a hedge against that.

Not only is the price fixed, when the debt is paid, there is no fuel cost—unless Exxon buys the Sun. If there is no fuel cost, it is a few cents a kilowatt hour. It becomes a clean cash cow. It is like a hydro plant that is paid for, but it is clean. Any utility that owns one of these, like PG&E, will be very happy that they have it.

So it is a very sound investment. The fact that it is a little costly now, that is what the ITC is helping to deal with. But as an investment, it is the most prudent investment that the country can make, and a lot of renewables have this same factor. They don't have a fuel price issue.

Mr. WAN. I would like to just offer a few numbers to illustrate the point. For example, if a natural gas combined-cycle power plant today is producing energy at roughly 10 cents, probably 40 percent of that is from the fixed cost of construction or maintenance, and the other 60 percent or so will be coming from the price of natural gas.

So Mr. Morse's point earlier, that 6 cents could be quite volatile in the future, and in his example, if CSP cost more than 10 cents today, but you are essentially locking in that number. Maybe it would be 11 or 12 cents. But you are far safer, from a portfolio management perspective, to have some CSP in your portfolio.

Senator SANDERS. Mr. Chairman, may I ask——

The CHAIRMAN. Sure.

Senator SANDERS. OK. We have been focusing, appropriately enough, on the huge potential of concentrated solar. When I was at Nellis, I was also impressed by the use of photovoltaic. So we talked to some people in the Energy Department a couple of months ago who surprised me by saying that they expect photovoltaic costs to also go down very substantially in the coming years and for people to install them on their rooftops.

California has had good success, New Jersey. Germany certainly has gone off the wall on this. What do you guys see as the potential of photovoltaics in the energy mix in this country?

Mr. WAN. As I mentioned earlier, we are in the final stages of negotiations with several of the PV developers, including the one at Nellis. The numbers they have all asserted to us are surprisingly low. We have thought for quite a while that CSP would be the future without any question, and I think PV is going to give CSP a run for the money. I think that is ultimately in the best interest of our consumers, for all Americans, as you have more competing industries and technologies to bring down the cost.

I think the key to photovoltaic today is not necessarily the efficiency of the panels or cells or to bring the cost down. It is actually the worldwide logistics of parts as well as the installation. That is why you see large-scale installation such as at Nellis.

Senator SANDERS. The beauty of PVs is that while in the Northeast we are not going to be installing in the near future concentrated solar, we can be heavily utilizing PVs.

I mean, Germany is not an optimal location for solar exposure. It is nowhere near what it is here, for example. But New Jersey and other States, and we are trying to do this in Vermont, is to expand the use of PVs.

So you see great potential there as well?

Mr. WAN. We see great potential. We are very hopeful.

Senator SANDERS. Yes, Mr. Nelson.

Mr. NELSON. Senator, I would like to give you our perspective on that. We actually are going to have another renewable energy RFP go out in the August timeframe. With that, it is going to be more of a general renewables RFP that we expect will include proposals related to PV, to biomass, to geothermal. We believe that PV plays a significant role in the renewable energy mix.

At this point in time, we believe that is more of a distributed role. Not just distributed in terms of rooftops, but megawatt scale located throughout the system to support distribution and that sort of thing. We are not yet, at this point in time, convinced that hundreds of megawatts in a single location is the most appropriate use for PV due to the large ramp rate associated with that when cloud cover comes over.

Senator SANDERS. Mr. Andraka.

Mr. ANDRAKA. I would like to echo the comments of Mr. Wan on the photovoltaics. One of the barriers is the interconnects, the field installation. One of the areas the laboratories are working on is modular systems, where you have got the PV built into a module and combined with an inverter. So it is an AC module that bolts into place to simplify and reduce the cost of the field installations.

Senator SANDERS. Mr. Chairman, thank you very much.

The CHAIRMAN. Thank you very much.

Let me ask one issue that is always at the forefront here in the Southwest and New Mexico is water. Is there a significant issue of water usage in connection with a CSP facility like the one you are doing in Arizona or like the one PNM is proposing to do here?

Mr. MORSE. It is all a problem of the French. Mr. Cugnot burdened us with the need if you have a heat engine, a steam turbine, you have to cool. You have to condense the fluid. A CSP plant, a trough plant or a power tower, is the same as any conventional plant. Coal, nuclear, doesn't matter. So we use the same amount of cooling water per megawatt.

We could go to completely dry cooling, air cooling. The cost would go up about 10 percent, and the performance, worst of all, would go down. During the hottest peak time, we would lose more performance. The solution that a lot of CSP developers are looking into is hybrid cooling, where we do dry cooling except during the very peak time, the hottest time, when we use a little bit of cooling water.

So I think that if the Southwest wants to have its future plants without water cooling, it can be done, and it is a matter of both a little cost and a little performance.

The CHAIRMAN. Yes? Mr. Nelson, do you have a point of view on that?

Mr. NELSON. Yes, sir. I would point out that our RFP actually requires that the vendors propose both dry and hybrid cooling options. We allow them to propose a wet cooling option as well, but we believe that the dry or hybrid is probably the way we need to go because of sustainability reasons. Water is a significant resource for us.

The CHAIRMAN. On this issue about the cost per kilowatt hour, as I understand, one of these concentrated solar operations—concentrating solar power plants, one of the great advantages is that it is producing the power when you are at your peak as far as demand. At least in the summer when people are using their air conditioners, you have got the most power going into the grid at that time.

How does that factor in? First, tell me if that is true as one of the advantages that concentrated solar has over wind power, for example. You just can't predict when the wind will blow.

Second, how does that relate to this cost per kilowatt hour issue? Because you have real-time pricing being factored in by Public Utility Commission, where you are charging a higher price per kilowatt hour during the peak periods, and you are producing this power even if it is more expensive during peak periods. How does all that fit together?

Mr. NELSON. We currently in New Mexico do not have peak or time of day pricing here, although that is certainly an option for

the future. Solar power, however, does more closely meet our peak than wind power does, although it is not a perfect match. That is why we believe storage has the option to get us through our true peak, which is generally when people are coming home at the end of the day, turning on their air conditioning, turning on the TVs, the computers, the stoves, and that sort of thing.

So storage can help us get from that 5 o'clock to 8 o'clock at night type peak. But solar does match it much better than wind. What we know here in New Mexico is we have a great wind resource. However, the windy days are rarely the very, very hot days here in New Mexico.

We generally see our greatest wind resource in what we call the shoulder months, the springs, the falls. At nighttime, where our load demand is significantly less. So, again, from that perspective, solar better matches our peak.

The CHAIRMAN. Yes.

Mr. ANDRAKA. We do see quite a diversity in the load profiles. For example, the Phoenix area, the peak extends maybe to 8 o'clock or 9 o'clock at night, and their request for proposals specifically require storage, and the plant that Dr. Morse proposes includes 6 hours of storage because of that requirement.

At the same time, the Southern California plants are not requiring storage. Their peak is a closer match to solar, still not a perfect match. But they also have significant wind resources, and those wind resources really start picking up every evening with the breezes off the ocean. So, in California, we see a portfolio of renewables in meeting that need.

Now as the solar resources are exploited and become a much greater portion of the grid, I think we will see more and more in California the need for storage, at least for the intermittency as used, if not the shifting.

The CHAIRMAN. OK. Yes, Mr. Wan.

Mr. WAN. Getting back to your question on the pricing, what you were hearing earlier is the average price. In California, we do pay a time of the day, time of the use value pricing. So that means if you are producing at the peak of the day, you can get up to 150 percent of that price that you heard earlier.

Similarly, if you are producing like wind in the middle of the night, you may get a lot less than that pricing. CSPs, we find, are critically dependent on the higher pricing for the power they produce over the peak of the day.

The CHAIRMAN. So you think that the time of day pricing that you have in California makes a lot of sense as you go to something like more power production from solar?

Mr. WAN. Absolutely.

The CHAIRMAN. Right.

Mr. WAN. Absolutely. Appropriately also pays the other technology less when they are not producing at the right time.

The CHAIRMAN. Mike, did you have a comment?

Mr. DALY. I just think, as I am listening—I can't speak for the other colleagues here—the not having a strong research program in solar storage, while it has been implemented in two or three situations in a solar tower, is the Achilles heel of the solar—concentrated solar business because if we can't store it, then we have

to build gas plants to back it up anyway, and you are double-building capacity, which is going to hurt the rate bearer.

So as you look at research dollars, the solar storage really makes a big difference in this business. Then the second step is getting the local PRC to start doing time of day pricing so you start having market-driven consumption, which will add to the efficiency. But that is more of a local issue.

But storage is really important, and while it has been implemented, it is not widespread proven technology. It is a credit risk, and it is expensive to do it.

The CHAIRMAN. Senator Sanders, do you have other questions? Go ahead.

Senator SANDERS. Just maybe one more, Mr. Chairman. To reiterate, I think this has been a very productive hearing, and I want to thank you for calling it and all of the panelists for being here.

My last question has to do with your views on a national renewable portfolio standard. My understanding is that New Mexico is moving to 20 percent by the year 2020, Nevada 15 percent by the year 2013. Other States have gone forward more or less significantly. We tried, and we lost by one vote, was it?

The CHAIRMAN. It was close, yes.

Senator SANDERS. One or two votes. It was 15 percent, I think, right?

The CHAIRMAN. It was 15 percent, right. By 2020.

Senator SANDERS. Right, 15 percent by 2020. What impact would a national renewable portfolio standard have on the solar industry?

Mr. Andraka.

Mr. ANDRAKA. As we mentioned earlier, the primary resource is in the Southwest United States. So I think our States would be at a distinct advantage in taking advantage of the solar resource. Your meeting a few weeks ago on transmission capability needs to also look at transmission across the country, totally different grid technology to bring this resource to other parts of the country.

Senator SANDERS. We have got a lot of work to do on that.

Mr. ANDRAKA. Yes.

Senator SANDERS. Yes, Mr. Wan.

Mr. WAN. PG&E has been a long supporter of the adoption of a national renewable strategy. We believe it should be uniformly applied. I think the most important part is that a national RPS policy will actually accelerate development and bring down the cost with greater scale and just move us so much faster and so much closer to the clean energy world that we would like to see.

Mr. MORSE. I would like to add a word of caution, however. I think the word "portfolio" has to be looked at carefully. It could be a wind standard very easily because it could go to the lowest cost, and at the moment, that is the lowest cost. But the value for the utilities has to be considered.

So I think, No. 1, it should not harm what may be more aggressive State RPSs or RPIs, whatever the plural is. I know that there is hesitancy about carve-outs, but a lot of solo ones exist because they had a percent had to be solar. I know that that is a contentious issue. But I think if you do have a national portfolio standard, please be very sensitive to how it will be implemented.

For the life of me, I never understood States who pass a State RPS for generation without thinking a bit about transmission or enough about transmission. So think about if you were to require X percent new generation from renewables, how on earth is that going to get to the load centers?

Senator SANDERS. Thank you, Mr. Chairman.

The CHAIRMAN. All right. Thank you all very much. Thanks for your testimony. I think it has been very useful. We will take all this information and try to put it to good use.

Thank you. That will conclude our hearing.

[Whereupon, at 11:59 a.m., the hearing was adjourned.]

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

RESPONSES OF MICHAEL DALY TO QUESTIONS FROM SENATOR DOMENICI

Question 1. I understand the DOD will be contracting for this power. Now that they can enter into 10 year contracts for renewable energy instead of just 5 years, will the Defense Department extend its contract with Mesa del Sol?

Answer. We met with DOD in New Mexico for the past 2 days. They are hesitant to pay a premium for concentrated solar, i.e. greater than 9 cents per kilowatt hour. They have agreed to work with us and the City of Albuquerque to look into developing a plant possibly in conjunction with the PNM RFP. It is our position to combine the load of the base and the New Mexico utility companies which will result in the lowest possible costs for solar thermal. While a longer contract is preferable, 10 years would be sufficient.

Question 2. How are you handling the project's thermal storage?

Is there room to expand at your site between Sandia and Kirkland AFB?

Answer. We are proposing 3 hours of solar thermal which is consistent with the PNM RFP. The entire site between Mesa del Sol and Kirkland AFB is approximately 2,700 acres which is more than sufficient to accommodate an excess of 400 MW of concentrated solar. We are proposing to start at the northerly end of the site and development to the south. To the extent the full site was developed, we would have to coordinate with the Base to make sure we wouldn't impact the rocket sled or other Sandia missions.

TRANSMISSION

Question 3. In the 2005 Energy Policy Act, Congress sought to address the critical issue of transmission siting through the National Interest Electric Transmission Corridor process. Even though these provisions haven't been fully implemented, and no line has been sited pursuant to EPAct, the NIETC process has proven controversial. Still, everyone here today has highlighted the critical need to bring more transmission on line to transport these renewable resources to load. Just this past weekend, the Albuquerque Journal ran an Op-Ed criticizing environmental groups—who want the "green" power but not the infrastructure that goes with it—for opposing needed transmission lines.

What more should Congress do in this important area? Some have called for Congress to provide FERC with exclusive jurisdiction to site new transmission for a renewable project. Please comment.

Answer. Where transmission corridors are required to promote renewable energy and there are not other economically viable paths, FERC should have power condemnation after conducting public hearings.

ITC

Question 4. One of the most important issues facing the solar industry today is that the tax credits we passed in a bipartisan manner are set to expire. We must enact a long-term ITC extension as soon as possible. However, for the first time in the renewable tax credit history, the House Majority is insisting that the tax credits be "offset" by tax increases on other industries.

Many of you have submitted testimony highlighting the tremendous economic boost the ITC provides the solar industry. According to Dr. Marker from SHOTT, solar capacity additions in 2007 contributed $2 billion to the U.S. economy, creating 6,000 new jobs. And, it's forecasted that if the ITC is extended, 62,000 manufacturing and distribution jobs will be created.

Do you agree that these tax credits "pay for themselves" and therefore don't need to be paid for by raising taxes on other industries? Is the renewable industry con-

cerned that this new "pay for" requirement can set a troubling precedent in that offsets will be required each time the existing tax credits expire?

Answer. The ITC should be extended to 8 years at a minimum, offsets should not be required to pay for the ITC as an impact on the economy will more than pay for any tax credits extended.

SOLAR RESOURCE POTENTIAL

Question 5. We currently have just over 400 MW of CSP installed capacity in this country, at a rate of about 16 cents per kilowatt-hour. A recent study suggests that solar energy could grow to 10% of the nation's power by 2025. Do you agree with that assessment? If so, what percentage will CSP contribute as opposed to Photovoltaic? Also, how long will it take to get solar power costs on parity with conventional power sources?

Answer. I agree with the assessment. We believe that CSP's will represent the majority of the grid scale solar generation and that photovoltaic is better suited to distribute energy primarily due to the fact that there does not seem to be a short term solution to storage for photovoltaic's vs. concentrated solar which has commercially viable options that can carry a plant's generation capacity through peak demands in many markets.

RESPONSES OF FREDERICK H. MORSE TO QUESTIONS FROM SENATOR DOMENICI

Question 1. I understand that you have a new 280 mw trough CSP project under development in Arizona and that this project will have a thermal storage component. How much cost does that add to the plant? Does the addition of storage capacity improve the project's economics since you'll be able to increase power generation over a longer period of time? Why didn't the recent Nevada CSP plant include thermal storage?

Answer. The addition of six full load hours of thermal energy storage at the 280 MW Solana plant will increase the capital cost by approximately 15-20%. However, by adding thermal energy storage, the cost of the electricity generated by this plant will decrease and the value of that electrify to Arizona Public Service increases significantly because it can be used when it is most needed. I do not know why Nevada Solar One did not use thermal energy storage but perhaps the utility wanted a peaker and did not value enough the ability to shift the electricity generation to other times.

Question 2. The site location for the Abengoa plant is located near an existing transmission line. Would you be able to proceed with this project absent that line?

Answer. No, not at this location. If we were to site Solana at another location in order to access transmission, we would need to determine if the added cost of wheeling or additional interconnection would make the project uneconomic.

Question 3. Do you expect your plant to take the typical 7-8 years to be completed? How long did the recent NV plant take to come on-line?

Answer. Solana is now expected to come on line in 2012, provided that the ITC is extended very soon. I do not know the time it took for Nevada Solar One to come on line.

TRANSMISSION

Question 4. In the 2005 Energy Policy Act, Congress sought to address the critical issue of transmission siting through the National Interest Electric Transmission Corridor process. Even though these provisions haven't been fully implemented, and no line has been sited pursuant to EPAct, the NIETC process has proven controversial. Still, everyone here today has highlighted the critical need to bring more transmission on line to transport these renewable resources to load. Just this past weekend, the Albuquerque Journal ran an Op-Ed criticizing environmental groups—who want the "green" power but not the infrastructure that goes with it—for opposing needed transmission lines.

What more should Congress do in this important area? Some have called for Congress to provide FERC with exclusive jurisdiction to site new transmission for a renewable project. Please comment.

Answer. More transmission is absolutely essential for moving renewable energy generated electricity to load centers. Its absence will certainly limit how much renewable energy can be developed. There is a clear need for some way to deal with the conflict over who can decide what lines get built and where. However, concerns about reliability and economics militate against granting renewable suppliers such a mandate. Additionally, the Energy Policy Act of 1992 prohibits discriminatory use

of the transmission system and therefore requires all generation resources equal access and use of the transmission grid.

The transmission system needs to be designed to integrate all sources of generation, in addition to renewable resources, into the entire system and managed as a whole, to be efficient and maintain reliability. To achieve a high level of penetration of renewable resources in an area, such as CSP, it must be able to interact with other areas to maintain the required real-time load-generation balance. That interaction requires sufficient transmission capacity between the areas, and this consideration alone will require expanding the system.

If giving FERC exclusive jurisdiction to site new transmission for renewable envy projects can withstand the likely challenge by the states, then this should be very helpful. For CSP, perhaps FERC's jurisdiction could be limited to siting new transmission from the solar zones that are under study by the BLM, the Western Governors' Association and the California Renewable Energy Transmission Initiative and to projects above a minimum size, say 250 MW.

ITC

Question 5. One of the most important issues facing the solar industry today is that the tax credits we passed in a bipartisan manner are set to expire. We must enact a long-term ITC extension as soon as possible. However, for the first time in the renewable tax credit history, the House Majority is insisting that the tax credits be "offset" by tax increases on other industries.

Many of you have submitted testimony highlighting the tremendous economic boost the ITC provides the solar industry. According to Dr. Marker from SHOTT, solar capacity additions in 2007 contributed $2 billion to the U.S. economy, creating 6,000 new jobs. And, it's forecasted that if the ITC is extended, 62,000 manufacturing and distribution jobs will be created.

Do you agree that these tax credits "pay for themselves" and therefore don't need to be paid for by raising taxes on other industries? Is the renewable industry concerned that this new "pay for" requirement can set a troubling precedent in that offsets will be required each time the existing tax credits expire?

Answer. I am well aware of the opposing views on if and how the ITC extension should be paid for however I am not in a position to comment on that. Solar energy has become another engine of the US economy and the extension of the ITC will allow solar to continue creating more jobs, contributing to economic growth and helping to reduce carbon emissions. Failure to find a way to extend the ITC now will result in the loss of over 25,000 jobs and the loss of the economic benefits of about $18 billion in investment in the 4, 800 MW of CSP plants now under contract but not financeable without the eight year extension of the ITC. And this at a time when America is trying to stop the loss of jobs and address serious energy concerns. I hope that a way can be found to pass the renewable energy tax credit extensions. To stop solar in its tracks seems like the wrong outcome for America.

SOLAR RESOURCE POTENTIAL

Question 6. We currently have just over 400 MW of CSP installed capacity in this country, at a rate of about 16 cents per kilowatt-hour. A recent study suggests that solar energy could grow to 10% of the nation's power by 2025. Do you agree with that assessment? If so, what percentage will CSP contribute as opposed to Photovoltaic? Also, how long will it take to get solar power costs on parity with conventional power sources?

Answer. A study done by NREL estimates that CSP could provide nearly 120, 000 MW of capacity by 2050. Although this represents only about 6.8% of the nation's power, it would be a significant percentage of the power needed by the Southwest. The NREL analysis assumed all CSP power stayed within one state from where it was generated. This assumption exemplifies the fact that the growth of CSP power is limited by transmission. If DC transmission were available to move power from the SW to the East, CSP's potential would be greatly expanded. From a national perspective, solar power could be particularly beneficial to the eastern half of the country because the sun shines in the West throughout the East's evening high demand period. Because PV can produce electricity throughout the country, its potential could be higher than that of CSP. Regarding the time it will take for solar power to achieve parity with conventional sources, I believe that if the ITC is extended for eight years, CSP will be cost competitive with convention power by the end of those eight years. However, both CSP and conventional power will increase due to increased commodity prices.

RESPONSES OF CHARLES E. ANDRAKA TO QUESTIONS FROM SENATOR DOMENICI

Question 1. According to Sandia, it is possible to lower the CSP costs from today's 16 cents per kwH, to 12 cents in the near-term and even 6 cents in the long-term. How long do you estimate it will be before CSP drops to 12 cents? 6 cents?

Answer. The cost reductions for CSP technology, as for any emerging power system, are largely dependent on deployment. The costs to which you refer are from a 2003 report done by the DOE for the National Research Council,[1] commonly referred to as the "Sergeant and Lundy Report." While the costs of all technologies, especially fossil-fuelbased, have increased in the interim, this study reports that the cost reductions for trough and tower systems will result about equally from three sources: deployment, learning-curve cost reductions related to financing; and R&D of new components. The study indicates that cost reductions as low as 10 cents could be achieved with as little as 3 to 5 GW of deployment of CSP systems. (Note: there are currently 4 GW of CSP projects planned for deployment in the southwest.) The lower end of the scale, in the 6 cent range, requires aggressive technical advancement as well as deployment, as stated in the Sergeant and Lundy report:

> The specific values will depend on total capacity of various technologies deployed and the extent of R&D program success. In the technically aggressive cases for troughs / towers, the S&L analysis found that cost reductions were due to volume production (26%/28%), plant scale-up (20%/48%), and technological advance (54%/24%).

The net of these aggressive reductions reaches the 6 cent range. The original Sergeant & Lundy study is currently being updated and new number should be available late in the Fall. It should also be noted that the 6 cent range was seen in 2003 as the level needed to be competitive with conventional fossil technologies. The current market conditions will likely raise this competition level closer to 10 cents.

While it is not possible to say exactly when the cost of CSP systems will drop below 12 cents per kWhr, it was reported that a recent large US trough project was bid at 14 cents per kWhr.

Question 2. To date, there are no Power Tower CSP projects in this country, although an 11 MW project just came on-line in Spain. What are the advantages/disadvantages to this technology? Why aren't we seeing any Power Tower projects developed in the U.S.?

Answer. An 11 MW power tower project was built in Spain because of the favorable CSP incentive structure that will pay 47 UScents/kWhr for power from CSP; because a large company (Abengoa Solar) recognized a worldwide business development opportunity; and because of an additional government subsidy for the project.

As noted in the Sargent & Lundy report, the power tower has a longer-term cost advantage relative to solar trough systems. This is largely due to the fact that a power tower is a higher efficiency system and can more readily integrate thermal storage, thereby improving the capacity factor (yearly hours of operation) and potential value to the utilities.

So far we have not seen the deployment of power towers in the U.S. because of the perceived technical and financial risks. Due to the large initial capital investment needed for these projects, it has been difficult to obtain power purchase agreements and financing for higher risk projects. However, there is one power purchase agreement for a power tower in California between Pacific Gas & Electric and BrightSource energy. At least two other companies, eSolar and Solar Reserve, are actively developing projects in the southwest U.S.

The fact remains that we must find a way to enable the deployment of higher-risk, technologies at the utility-scale of solar power.

Question 3. I understand that Sandia is studying the new 64 MW CSP project in Nevada. What are you learning from that project? Why didn't that project include a thermal storage component?

Answer. The Nevada Solar 1 project was funded by private industry. Sandia is familiar with the technology and has worked with the developer, Solargenix, in the past but we do not have access to the data on the operation of the plant.

This system does not include thermal storage for two reasons: the utility, Nevada Power, did not value thermal storage to increase the capacity factor of the plant and they wanted the lowest cost solar option.

It should be noted that, even though two trough plants with storage are under construction in Spain, thermal energy storage for trough systems is not well estab-

[1] Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts, prepared for the Department of Energy and National Renewable Energy Laboratory, SL-5641, May 2003.

lished and some utilities and financial institutions consider it to be a higher risk technology. The announced 280 MW trough plant for the Phoenix area also includes thermal storage. While extending troughs to include storage is a current area of intense DOE and industry research, the potential for storage in towers appears to be much greater. This is because of the higher temperatures inherent in tower systems, which leads to less storage volume for a given level of storage. In addition, current storage proposals for troughs have a separate storage medium, requiring an expensive heat exchanger, whereas towers store the energy in the operating fluid (salt). We expect that current DOE development will support an increase in the number of plants, both towers and troughs, that incorporate thermal storage.

Question 4. Currently, a CSP project requires approximately 5 acres of land per megawatt. Is there room for improvement?

Answer. There is a small difference in the area required for a trough, a tower, and dish/Stirling systems. The size of the solar field for all three of the technologies is driven by shading issues in the morning and evening, as well as mid-day in the winter when the sun is lower in the sky. Any reduction in the area required for the concentrators will be incremental because it depends on the fundamental optics of concentrating sunlight. The plant concentrator area could be reduced by tradeoffs that the developer would make between energy production at certain times of year and plant foot print.

TRANSMISSION

Question 5. In the 2005 Energy Policy Act, Congress sought to address the critical issue of transmission siting through the National Interest Electric Transmission Corridor process. Even though these provisions haven't been fully implemented, and no line has been sited pursuant to EPAct, the NIETC process has proven controversial. Still, everyone here today has highlighted the critical need to bring more transmission on line to transport these renewable resources to load. Just this past weekend, the Albuquerque Journal ran an Op-Ed criticizing environmental groups—who want the "green" power but not the infrastructure that goes with it—for opposing needed transmission lines.

What more should Congress do in this important area? Some have called for Congress to provide FERC with exclusive jurisdiction to site new transmission for a renewable project. Please comment.

Answer. There are two approaches to address the nations growing electricity demand, through centralized generation and through distributed generation. Centralized generation includes coal, nuclear, wind farms, concentrated solar power plants, photovoltaic arrays, geothermal energy and other generation sources that produce electricity on the megawatt through gigawatt scale. Most of this centralized generation connects to the grid at the transmission or subtransmission voltage level. Much of the available renewable resources exist in locations where transmission is not available to transport the energy to the loads. In this case, new transmission lines are needed to make large quantities of renewable power available where it is greatly needed. The 2006 National Electric Transmission Congestion Study identified critical congestion areas based on current and projected growth. There are many barriers to get the needed transmission sited and installed including regulatory, cost recovery, and technical issues. Giving FERC exclusive jurisdiction in siting new transmission for renewables does not solve the problem about who pays for new transmission. A technical challenge that has not been addressed with the high penetration of renewables is grid stability. Utilities are now running into problems with maintaining frequency stability with large amounts of intermittent generation such as wind and solar. This is primarily due to the fact that currently deployed versions of these renewable resources are not dispatchable, in other words we only have wind energy when the wind blows and photovoltaic energy when the sun shines. This is unlike fossil, nuclear, and geothermal generation that we can dispatch as needed because we have control of the fuel source at the generation plant as needed. Utilities have compensated by running dispatchable fossil generators as "spinning reserve" to compensate for renewable intermittency, which is not always cost effective. There is concern that increasing the penetration of renewables on the electric grid will increase stability problems. A key technology that will enable the dispatchability of renewables and help alleviate the stability problem is energy storage. Significant additional research is needed in this area. Concentrating solar power is one renewable technology that can incorporate storage technology through molten salt.

The second approach to meeting the nations growing electricity demand is through the use of more distributed generation. This includes rooftop photovoltaic panels, photovoltaic arrays at distribution voltages, distributed wind, fuel cells, and

other small generation resources that can be placed at or very near the load. This approach is attractive for remote load sites and where new transmission is not a viable option. There are numerous challenges that have been identified by increasing the penetration of renewables at the distribution level through the DOE Renewable Systems Interconnection (RSI) initiative . This set of studies completed in December 2007 outline the challenges for distributed photovoltaics in the categories of 1)Distributed PV System Technology Development, 2)Advanced Distribution Systems, 3)System Level Test and Demonstration, 4)Distributed Renewable Energy System Analysis, 4) Solar Resource Assessment, 6)Codes, Standards, and Regulatory Implementation. However, these studies only identify some of the problems and funding is not in place to address the identified challenges. While these studies focus on distributed photovoltaics, the concepts are applicable to most renewables.

In summary, transmission siting is just one element of the renewable interconnection challenge. Further research in renewable systems interconnection is needed to address the technology needs, codes and standards, business models, and regulatory issues to assure that we maintain a secure and reliable electric grid as we increase the penetration of renewables in the US.

ITC

Question 6. One of the most important issues facing the solar industry today is that the tax credits we passed in a bipartisan manner are set to expire. We must enact a long-term ITC extension as soon as possible. However, for the first time in the renewable tax credit history, the House Majority is insisting that the tax credits be "offset" by tax increases on other industries.

Many of you have submitted testimony highlighting the tremendous economic boost the ITC provides the solar industry. According to Dr. Marker from SHOTT, solar capacity additions in 2007 contributed $2 billion to the U.S. economy, creating 6,000 new jobs. And, it's forecasted that if the ITC is extended, 62,000 manufacturing and distribution jobs will be created.

Do you agree that these tax credits "pay for themselves" and therefore don't need to be paid for by raising taxes on other industries? Is the renewable industry concerned that this new "pay for" requirement can set a troubling precedent in that offsets will be required each time the existing tax credits expire.

Answer. We do not have the data to document the net "value" of the Investment Tax Credit. However, analysis for states in the southwest has shown that the development of CSP projects has a positive value to state and local economies over the lifetimes of the projects. Specific examples have been sited in several reports.[2 3 4]

SOLAR RESOURCE POTENTIAL

Question 7. We currently have just over 400 MW of CSP installed capacity in this country, at a rate of about 16 cents per kilowatt-hour. A recent study suggests that solar energy could grow to 10% of the nation's power by 2025. Do you agree with that assessment? If so, what percentage will CSP contribute as opposed to Photovoltaic? Also, how long will it take to get solar power costs on parity with conventional power sources?

Answer. With the sustained incentive of the 30% ITC through 2017, the study results presented at the hearing predicts a deployment of 22 GW by 2025.[5] If the ITC were extended through 2025, the total deployment could be 40 GW as predicted by the same methodology presented in this reference. To reach 10% of the current U. S. grid capacity or about 100 GW by 2025 would require more aggressive incentives, significant streamlining of approval processes, and aggressive expansion of transmission capabilities.

CSP and photovoltaics are primarily focused on different market sectors. CSP is focused on the wholesale, utility-scale power market and photovoltaics are currently being applied to the "higher value" distributed, retail power market. The very large CSP installations are centrally sited, permitted, and maintained, but compete at

[2] The Economic Impact of Concentrating Solar Power in New Mexico, The University of New Mexico, Bureau of Business and Economic Research, December 2004.

[3] The Potential Economic Impact of Constructing and Operating Solar Power Generation Facilities in Nevada, Final Report, R. Keith Schwer and Mary Riddel, Center for Business and Economic Research, University of Nevada, Las Vegas, July 2003

[4] Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California, Deliverable 3 Final Report, Black and Veatch, Prepared for National Renewable Energy Laboratory Under Subcontract AEK-5-55036, September 2005

[5] Department of Energy Solar Energy Technologies Program, Multi Year Program Plan, 2008-2012, April 2008. Plan available at: http://www1.eere.energy.gov/solar/pdfs/solar_program_mypp_2008-2012.pdf.

utility generation rates. The bulk of current PV installations are distributed, either at the rooftop level or in relatively small power plants, are sited, permitted, and maintained by the owners, and compete financially on the customer side of the meter (retail pricing). The deployment scenarios and incentives are very different to reflect the needs and unique characteristics of these two markets. U. S. deployment of photovoltaics is predicted to be 20 to 25 GW by 2025 in the photovoltaics roadmap.[6] If the cost of photovoltaics falls as some think it may, it is possible that in the future PV may also compete in the utility-scale markets, as it currently does in Spain.

Even with the increase in the cost of commodities, CSP costs are projected to continue to decrease. The current cost of conventional pulverized coal power continues to increase with anecdotal costs indicated to be in the 5 to 7 cents/kWhr range. More importantly, uncertainty over future carbon regulation is resulting in the cancellation of orders for new pulverized coal plants. Carbon capture is projected to increase the cost of coal by an additional 5.4 cents/kwhr,[7] perhaps more if gasification technology is utilized. This means that the gap between the cost of generating a kWhr of electricity using pulverized coal and CSP and other sources of renewable electricity is growing smaller. As discussed during the testimony, once a solar plant is installed, the cost of electricity generated is relatively stable over the life of the plant, while conventional technology energy costs are highly dependent upon the cost of fuel.

RESPONSES OF ALEX MARKER TO QUESTIONS FROM SENATOR DOMENICI

Question 1. You testified that eventually, solar storage could produce electricity 24/7 without the need for natural gas back-up. Currently, our solar storage capabilities are about 6 hours. When do you envision a 24/7 CSP plant?

Answer. It is technically possible to continuously operate a CSP trough plant based on technology available today. However it may not be economically competitive with baseload power generation. Many utility companies have a need for cost competitive peak power, which is what's driving demand for CSP technology.

CSP power plants, with thermal storage on the order of six hours, will provide utilities peaking capability that extends into the evening hours. With proper Federal incentives and policy, CSP can be competitive with other technologies for providing peak power, with the ultimate goal of continuous cost-competitive power generation. A long-term extension of the ITC will spur this research and will drive innovation.

Question 2. When your manufacturing plant comes on-line next Spring, how many megawatts of solar collectors will you be able to produce on an annual basis?

Answer. SCHOTT Solar anticipates having several production lines to manufacture receivers for parabolic trough concentrated solar power (CSP) plants. Each one of these lines will produce enough receivers capable of producing between 100MW and 200MW of annual power. Initial plans call for the facility to have two receiver production lines.

The broad range in output from each line is variable due to where the receivers are installed, and the overall size and efficiency of the projects they will be integrated into.

The facility is being designed with future expansion in mind, to accommodate the anticipated rapid growth of the utility-scale CSP market. SCHOTT Solar's further growth in Albuquerque is contingent upon worldwide market demand.

TRANSMISSION

Question 3. In the 2005 Energy Policy Act, Congress sought to address the critical issue of transmission siting through the National Interest Electric Transmission Corridor process. Even though these provisions haven't been fully implemented, and no line has been sited pursuant to EPAct, the NIETC process has proven controversial. Still, everyone here today has highlighted the critical need to bring more transmission on line to transport these renewable resources to load. Just this past weekend, the Albuquerque Journal ran an Op-Ed criticizing environmental groups—who want the "green" power but not the infrastructure that goes with it—for opposing needed transmission lines.

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[6] Solar Electric Power, The U.S. Photovoltaic Industry Roadmap, May 2001, available at http://photovoltaics.sandia.gov/docs/PDF/PV_Road_Map.pdf

[7] Reducing U. S. Greenhouse Gas Emissions: How Much at What Cost?, U. S. Greenhouse Gas Mapping Initiative, Executive Report, December 2007. (aka, the McKinsey Report)

What more should Congress do in this important area? Some have called for Congress to provide FERC with exclusive jurisdiction to site new transmission for a renewable project. Please comment.

Answer. An expanded transmission grid is absolutely essential for moving renewable energy to customers. The current transmission grid was built decades ago to connect traditional fossil fuel generation with the load centers. Any carbon-free energy paradigm will require new transmission lines to once again connect customers with their desired power source—this time, solar, wind and other clean energy resources.

The lack of investment in our transmission grid will limit how much renewable energy can be delivered, and therefore developed. As you heard at the committee's June 17 hearing on transmission challenges, there is a clear need to deal with the problems around building new transmission lines.

One solution might be to give FERC exclusive jurisdiction to site new transmission lines, similar to its authority to site natural gas pipelines. Another solution may be multi-state regional cooperation, where public utility commissions, utilities and project developers could pool resources and expertise to propose new transmission lines to the benefit of all involved.

There are currently several cooperative efforts going on in the West—the Western Governors' Association Western Renewable Energy Zone initiative and California's Renewable Energy Transmission Initiative—which seek to both identify areas rich in renewable resources and the transmission necessary to move that power to end-use customers.

ITC

Question 4. One of the most important issues facing the solar industry today is that the tax credits we passed in a bipartisan manner are set to expire. We must enact a long-term ITC extension as soon as possible. However, for the first time in the renewable tax credit history, the House Majority is insisting that the tax credits be "offset" by tax increases on other industries.

Many of you have submitted testimony highlighting the tremendous economic boost the ITC provides the solar industry. According to Dr. Marker from SHOTT, solar capacity additions in 2007 contributed $2 billion to the U.S. economy, creating 6,000 new jobs. And, it's forecasted that if the ITC is extended, 62,000 manufacturing and distribution jobs will be created.

Do you agree that these tax credits "pay for themselves" and therefore don't need to be paid for by raising taxes on other industries? Is the renewable industry concerned that this new "pay for" requirement can set a troubling precedent in that offsets will be required each time the existing tax credits expire?

Answer. SCHOTT Solar ("the company") strongly believes that a long-term (8-year) extension of the ITC is an essential component in developing a long-term, sustainable market for solar energy in the United States. The company has not engaged in analyzing the financial impact of an extension of an ITC beyond the effects it will have on SCHOTT Solar's immediate business.

A study recently prepared by GE Energy Financial Services (June 2008) concluded that the ITC would " pay for itself" through continued investment and employment numbers.

It should be considered, and cautioned, that although the ITC is one of the most important factors in developing the solar market in the United States, it is not the only factor. Market development may not grow as forecasted.

Regarding setting a precedent for renewing the ITC—the market will rapidly develop, and consequently change, between now and when the ITC (if extended for the long-term) will be set to expire. SCHOTT Solar trusts in the Federal government to make an informed, and appropriate decision relating to extensions of the ITC, based on market analysis available at that time.

SOLAR RESOURCE POTENTIAL

Question 5. We currently have just over 400 MW of CSP installed capacity in this country, at a rate of about 16 cents per kilowatt-hour. A recent study suggests that solar energy could grow to 10% of the nation's power by 2025. Do you agree with that assessment? If so, what percentage will CSP contribute as opposed to Photovoltaic? Also, how long will it take to get solar power costs on parity with conventional power sources?

Answer. The potential of solar energy is almost limitless, especially in the Southwest of the United States, where, if just 2.5% of the usable land were converted into CSP power plants, it would satisfy the entire nation's energy needs (at 2006 usage).

Before directly answering the question, it should be noted that the 16 cents per kilowatt-hour is an aggregated figured based upon the "first generation" of parabolic trough CSP plants (SEGS). Costs will continue to decrease through technological developments, economies of scale in constructing the sites, and improvements in transmission. At Acciona Energy's "Nevada Solar One " facility in Boulder City, NV, it is estimated that the cost to generate electricity from the facility is fixed at 3 cents per kilowatt hour (not inclusive of amortizing the cost of constructing the facility).

ENERGY MIX

Whether or not the nation will be able to consume 10% of its energy from solar powered sources, is contingent upon the speed and ease in which large-scale solar facilities will be allowed to set-up, operate, and provide power to the grid. A long-term extension of the ITC is a key component in allowing this rapid market development. A Federal Renewable Portfolio Standard (RPS) would motivate utilities to buy and consume renewable energy. Streamlining and standardizing grid connection and transmission will also create a powerful climate for the rapid growth of CSP.

PERCENTAGE OF CSP VS. PV

CSP and PV are complementary technologies (much like wind and solar are complementary). PV is mainly used for distributive power generation, where the power produced is consumed at that location. With only a handful of notable exceptions, PV installations generally do not exceed 1MW in capacity.

CSP, however, is a utility-scale, central station technology where installations generally achieve production exceeding 50MW capacity. Although it is possible to construct and operate smaller scale CSP power plants, through economies of scale, they are not cost-competitive.

Due to the sheer size of CSP power plants, as well as the speed in which they're able to be constructed (for reference, Accciona Energy's Nevada Solar One was producing power a year after ground was first broken), and no foreseen raw material supply constraints, under the right climate—tremendous CSP growth is possible. As a point of reference, there are currently 4, 000 MW of CSP projects currently in the planning / permitting stage. With a clear signal of support from the Federal government in this clean, fixed cost, domestically produced energy source—many of these projects will shift from planning to construction and many more will enter the planning stage.

It is difficult to assign an exact figure for PV growth over the eight year term of an ITC extension, as the nature of projects are generally much smaller. One can look at PV manufacturing capacity (which is rapidly developing) but it is unknown how much PV will be imported from overseas, and conversely, how much will be exported from the U.S. It is for this reason, that I apologize I am unable to provide the committee with an exact answer to this question.

CLOSING REMARK

Distinguished committee members, on behalf of the solar industry, and SCHOTT Solar, we appreciate your continued efforts to focus on the promise and possibility of solar energy. The benefits of the technology are numerous, not only from an environmental standpoint, but also as an economic engine. Solar energy has tremendous support across the country. 94% of Americans, in a recent poll, stated it is important for the U.S. to develop and use solar energy, and approximately 75% of Americans favor a long-term extension of the ITC. This is an issue we all agree on.

The United States and New Mexico stand to reap a tremendous economic benefit from a long-term extension of the ITC. There is no reason why New Mexico can not take a global lead in renewable energy.

In twenty years I am confident that, when flying across the desert Southwest, a glimmer of light will catch my eye from a parabolic mirror, focusing the sun's energy on a receiver, which will be providing clean, reliable, fixed cost energy across the U.S. And I will think back to this time, and the hard work we are all undertaking.

It is through your leadership and guidance that the United States will return to its position as a clean energy leader.

RESPONSES OF FONG WANG TO QUESTIONS FROM SENATOR DOMENICI

Question 1. You testified that last year, approximately 12% of PG&E's electric delivery mix was comprised of renewable resources. How much of this is comprised by solar? How much wind have you added to meet California's RPS requirement?

Are you on target to meet the State's goal of 33% of renewable energy by 2022? Isn't there an initiative to raise this goal even further, to 50%?

Answer. In 2007, the breakout of PG&E's 12 percent California-eligible[1] renewable electricity delivery mix was as follows: solar, less than 1 percent; wind, 15 percent; California-eligible small hydroelectric, 21 percent; geothermal, 30 percent, and biomass and waste, 34 percent. (Note: the distributed solar installed by PG&E's customers does not count for PG&E's RPS requirement.)

Since the California RPS was created in 2002, PG&E has signed 39 contracts for 2,612 MW (up to 3,195 MW if all options are exercised). The amount of wind and other resources added are as follows:

	contracts	MW
Solar	6	1343
Wind	8	584
Geothermal	8	553
Bioenergy	14	129
Wave	1	2
Small Hydro	2	1
	39	2612

A 33 percent renewable energy standard has been proposed by the California Air Resources Board (CARB) as a key pillar to driving down greenhouse gas emissions in California. PG&E is reviewing that option and looking forward to working with the CARE and other interested parties going forward. We are committed to being a constructive part of California's drive to increase its use of renewable resources. We do believe, however, that as these requirements are debated and established, policy makers should carefully consider and must ensure that:

1. Appropriate tax and financial incentives are available,
2. Sufficient transmission has been built or approved to deliver newly developed renewable energy to customers,
3. Consensus is reached on the maximum price customers should be expected to pay for renewable energy, and
4. Reliability isn't jeopardized by over-reliance on intermittent energy resources.

We are confident these issues will be addressed, as they are necessary to ensure the viability and success of RPS requirements.

We do not support the current ballot proposal in California to raise the RPS level to 50%, and have joined a coalition with environmental groups, organized labor, and renewable energy producers to oppose this well-intended, but poorly drafted ballot initiative. We would recommend that you contact the coalition Californians Against Another Costly Energy Scheme (www.noprop7.com) for further information on this matter as it has been authorized to speak on behalf of all of its members.

Question 2. I understand that PG&E is working through California's Renewable Energy Transmission Initiative. Please elaborate. Are you working on any interstate transmission policies or are you concentrating wholly intrastate?

Answer. PG&E is an active participant in California's Renewable Energy Transmission Initiative, or "RETI." In addition to California, the footprint of the RETI analysis includes British Columbia, Washington, Oregon, Nevada, Arizona and Baja Mexico. This process will identify renewable resource areas that are well-suited for major new transmission investments, as well as specific transmission projects to access the identified areas. RETI is being developed in phases with the first phase focused on identifying the most promising renewable resource areas and the second phase focused on identifying conceptual transmission plans necessary to gain access to these areas. The initiative is modeled on the approach used in the Tehachapi area in California and also on the work done by ERGOT in Texas. The current scope of the first phase to identify renewable resource areas includes areas outside California. We recommend that federal legislation avoid creating conflicts with RETI and any other similar state-led initiatives in this area. Federal policies related to these efforts include interconnection policies that govern the process for interconnection studies and cost allocation for constructing any necessary transmission upgrades to support renewable development. Federal land use policies will also be a key issue in the ultimate development of the renewable resource areas and the associated transmission necessary to access those resources. Some of the lead federal

[1] As defined in California Senate Bill 1078, which created California's renewable portfolio standard, an eligible renewable resource includes geothermal facilities, hydroelectric facilities with a capacity rating of 30 MW or less, biomass, selected municipal solid waste facilities, solar facilities and wind facilities.

agencies are participating in the RETI process. The extent to which the land use policies of these agencies align with the goals of RETI has not yet been specifically determined.

PG&E is also supporting the Western Electricity Coordinating Council Transmission Expansion Planning and Policy Committee workgroups that are identifying interstate transmission options for supporting various renewable energy development scenarios in the West.

Question 3. How are you dealing with the transmission necessary to transport your solar energy?

Answer. PG&E and other California-based investor owned utilities have executed agreements to purchase power from a number of solar energy projects, however, the identification of the transmission method of service for these projects have been delayed due to the large number of generation projects in the CAISO interconnection queue. PG&E is actively participating in an effort by the CAISO to address its generation interconnection process with the aim of providing a clear path to interconnecting renewable resources in California. PG&E and the CAISO have also identified a major transmission upgrade opportunity to address reliability needs, improve access to energy storage facilities and improve access to renewable resources in southern California. The project does not specifically require interconnection of solar energy resources but is part of transmission expansion plans to access and integrate renewable resources in California.

Question 4. In the 2005 Energy Policy Act, Congress sought to address the critical issue of transmission siting through the National Interest Electric Transmission Corridor process. Even though these provisions haven't been fully implemented, and no line has been sited pursuant to EPAct, the NIETC process has proven controversial. Still, everyone here today has highlighted the critical need to bring more transmission on line to transport these renewable resources to load. Just this past weekend, the Albuquerque Journal ran an Op-Ed criticizing environmental groups—who want the "green" power but not the infrastructure that goes with it—for opposing needed transmission lines.

What more should Congress do in this important area? Some have called for Congress to provide FERC with exclusive jurisdiction to site new transmission for a renewable project. Please comment.

Answer. In California, PG&E has strongly supported efforts at the California Public Utility Commission (CPUC) and the California Independent System Operator (CAISO) intended to provide California utilities with the tools they need to proactively plan and develop transmission facilities for renewable sources of electricity. These efforts include the development of a category of needed transmission projects under the CAISO tariff for renewable trunk lines, as well as "backstop" cost recovery proposals at the CPUC intended to encourage utilities to exercise their right under FERC interconnection policy to provide up-front funding for RPS-related network upgrades where doing so makes sense for customers and the state's RPS goals.

Planning for and expansion of transmission is appropriately performed by transmission owners working in conjunction with appropriate state or regional transmission system operators. The application of FERC backstop siting authority should be consistent with state and regional planning efforts to develop and maintain coordinated transmission planning processes.

The states are generally best suited to address local and state issues concerning the siting and design and environmental review of state projects. However, PG&E sees FERC's backstop siting authority as a potential useful mechanism for ensuring the efficient processing of transmission corridors when states have not acted.

Specifically, in cases where local interests may prevent transmission facilities from being sited and the state has withheld approval, FERC involvement can be useful in moving the process along. For example, FERC's backstop siting authority may be most appropriate for interstate corridors with significant congestion, and where proposed interstate projects require approvals by multiple states with potentially conflicting objectives.

Question 5. One of the most important issues facing the solar industry today is that the tax credits we passed in a bipartisan manner are set to expire. We must enact a long-term ITC extension as soon as possible. However, for the first time in the renewable tax credit history, the House Majority is insisting that the tax credits be "offset" by tax increases on other industries.

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Do you agree that these tax credits "pay for themselves" and therefore don't need to be paid for by raising taxes on other industries? Is the renewable industry concerned that this new "pay for" requirement can set a troubling precedent in that offsets will be required each time the existing tax credits expire?

Answer. PG&E supports establishing long-term tax credits, and the market certainty that provides, such as the 8-year extension proposed in recent federal legislation. This will enable the solar industry to obtain the continued financial investment necessary to see these multi-year projects through from design, to construction, and to operation. This long-term tax credit approach will also enable the industry to establish a sufficient manufacturing base to achieve the economies of scale necessary to reduce costs and ultimately minimize the need for such subsidies. Conversely, the potential of this industry will be delayed or not be realized in an environment characterized by year-to-year extensions, and the market uncertainty created by such annual legislative processes.

Question 6. We currently have just over 400 MW of CSP installed capacity in this country, at a rate of about 16 cents per kilowatt-hour. A recent study suggests that solar energy could grow to 10% of the nation's power by 2025. Do you agree with that assessment? If so, what percentage will CSP contribute as opposed to Photovoltaic? Also, how long will it take to get solar power costs on parity with conventional power sources?

Answer. The study cited, "Utility Solar Assessment (USA) Study, Reaching Ten Percent Solar by 2025", projects that solar PV would provide 8 percent and CSP would provide 2 percent of total U.S. electricity. It would require an installation of 255 GW of solar by 2025 at a Compound Annual Growth Rate of 33 percent for PV and 28% for CSP.

The amounts projected are achievable, but to reach those values by 2025 would require 100 percent of the many assumptions to happen perfectly and on schedule. Experience tells us that rarely does that happen. We would expect the actual process to take somewhat longer.

Achieving grid parity between solar and local utility rates will be affected by several factors, including, among others, utility rate design, solar insolation in a given area, increases in fossil fuel costs, and carbon costs. It is expected that grid parity will be reached prior to the 2025 reference date, possibly as early as 2015 in some areas.

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