

EMERGING ENERGY TECHNOLOGIES

HEARING
BEFORE THE
COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE
ONE HUNDRED TENTH CONGRESS
FIRST SESSION

TO

RECEIVE TESTIMONY ON REDUCING BARRIERS TO GROWTH OF
EMERGING ENERGY TECHNOLOGIES—RELATIONSHIPS BETWEEN
FEDERAL, STATE, AND LOCAL GOVERNMENTS

ALBUQUERQUE, NM, AUGUST 7, 2007



Printed for the use of the
Committee on Energy and Natural Resources

U.S. GOVERNMENT PRINTING OFFICE

38-840 PDF

WASHINGTON : 2007

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512-1800; DC area (202) 512-1800
Fax: (202) 512-2104 Mail: Stop IDCC, Washington, DC 20402-0001

COMMITTEE ON ENERGY AND NATURAL RESOURCES

JEFF BINGAMAN, New Mexico, *Chairman*

DANIEL K. AKAKA, Hawaii	PETE V. DOMENICI, New Mexico
BYRON L. DORGAN, North Dakota	LARRY E. CRAIG, Idaho
RON WYDEN, Oregon	LISA MURKOWSKI, Alaska
TIM JOHNSON, South Dakota	RICHARD BURR, North Carolina
MARY L. LANDRIEU, Louisiana	JIM DEMINT, South Carolina
MARIA CANTWELL, Washington	BOB CORKER, Tennessee
KEN SALAZAR, Colorado	JOHN BARRASSO, Wyoming
ROBERT MENENDEZ, New Jersey	JEFF SESSIONS, Alabama
BLANCHE L. LINCOLN, Arkansas	GORDON H. SMITH, Oregon
BERNARD SANDERS, Vermont	JIM BUNNING, Kentucky
JON TESTER, Montana	MEL MARTINEZ, Florida

ROBERT M. SIMON, *Staff Director*

SAM E. FOWLER, *Chief Counsel*

FRANK MACCHIAROLA, *Republican Staff Director*

JUDITH K. PENSABENE, *Republican Chief Counsel*

CONTENTS

STATEMENTS

	Page
Bingaman, Hon. Jeff, U.S. Senator From New Mexico	1
Chavez, Martin, Mayor, Albuquerque, NM	3
Domenici, Hon. Pete V., U.S. Senator From New Mexico	2
Hou, Hong, Ph.D., President and Chief Operating Officer, Emcore Corporation, Albuquerque, NM	25
Schmit, Rusty, Co-Founder and Chief Executive Officer, Advent Solar, Albuquerque, NM	13
Simmons, Jerry A., Jr., Program Manager, Solid State Lighting, Sandia National Laboratories, Albuquerque, NM	16
Smith, Douglas, President, Nanopore Incorporated, Albuquerque, NM	10

EMERGING ENERGY TECHNOLOGIES

TUESDAY, AUGUST 7, 2007

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

The committee met, pursuant to notice, at 9 a.m., at the Albuquerque Convention Center, Hon. Jeff Bingaman, chairman, presiding.

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

The CHAIRMAN. Why don't we go ahead and get started. Thank you all for being here. We've got a sort of gathering of the leaders of the community to talk about a very important issue.

This is a hearing of the Energy and Natural Resources Committee of the Senate—a field hearing that we are having today at the suggestion of Mayor Chavez, which I appreciate very much his suggesting a couple months ago that we convene this to talk about some of the initiatives that are going on here in Albuquerque and in the State, both in the public arena, but also with private companies to promote more use of renewable energy, to promote more efficient use of energy, to create jobs and benefit economically from this transformation of our economy that I think we're all very aware of.

Let me begin by acknowledging Kathryn Clay who is here from Senator Domenici's office, she came from Washington to be part of this. I know she's here. All right. Joe Trujillo is representing the senator here in New Mexico and he does very well as we all know.

New Mexico and Albuquerque in particular are blessed with a wealth of technology, of course, that much of which resides in our national laboratories, Sandia, Los Alamos, Air Force Research Laboratory in particular, but others as well. In addition we have the University of New Mexico, we have New Mexico State, we have New Mexico Tech, all of which are high quality research institutions.

Over the years these laboratories and universities through their highly educated work force and state-of-the-art research facilities have made New Mexico a seedbed for new technology startups and high technology economic growth in a broad array of areas, from sophisticated computer codes to advanced materials and also emerging energy technology companies.

We have some of those with us today and some that are not here. Companies such as EMCORE and Advent, Tesla Motors, NanoPore, there are various successful companies that call this their home

and which have put New Mexico on the map with regard to clean energy and renewable energy.

The Council on Competitiveness, in their 2004 report “Innovate America,” called this mix of companies and research institutions, laboratories, an innovation ecosystem or an innovation cluster.

Today’s hearing is to explore the barriers that emerging energy technology companies encounter. Also how the Federal, State, and local government can help these companies to overcome these barriers. Obviously we need to look at all levels of government to get this job done.

Again let me just congratulate Mayor Chavez for the leadership he has shown in putting Albuquerque on the map as far as a leader in clean energy and moving the economy here to a clean energy future which I believe the entire country is aware of.

So he is going to be our witness on the first panel. I welcome Mayor Chavez. Why don’t you go right ahead.

[The prepared statement of Senator Domenici follows:]

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

I’d like to begin by thanking Senator Bingaman for calling today’s field hearing, and I’d also like to commend Mayor Chavez for organizing the conference coinciding with our hearing. Both the conference and the hearing are designed to call attention to an important issue for our nation as a whole, and for New Mexico in particular. That is the issue of the development and commercial application of new energy technologies.

Developing advanced energy technologies will be critical to our nation’s future success in meeting challenges relating to our energy security, our environment, and our national competitiveness.

Our witnesses today will provide us with their thoughts on how federal, state, and local governments can work more constructively with innovative companies like their own. We have a common goal, to bring new, advanced energy technologies out of the laboratory and into the marketplace. We need to do everything we can to make sure that government and the private sector are working together in a productive way to make that happen.

New Mexico is the perfect place to hold a hearing on this topic. We have a tremendous depth of talent and entrepreneurship that we can tap into, to build new companies and create new jobs based on advanced energy technologies.

Our witnesses today represent companies that are terrific examples of this kind of success. EMCORE, a leading maker of high-efficiency solar cells, started through licensed technology developed at Sandia National Laboratories. EMCORE, located in the Sandia Science and Technology Park, has created more than 500 high-paying jobs and invested more than \$100 million in developing and manufacturing advanced solar cell technology over the last nine years.

Advent Solar is another great example of what we are trying to achieve. Advent started as a “spin-off” from Sandia National Laboratory four years ago. Today, it has over \$120 million in equity and employs over 200 people.

NanoPore, a University of New Mexico spin-off, uses nanoengineering to make advanced materials capable of reducing insulation thickness by a factor of about twenty. This translates into large weight reductions on commercial refrigerated trucks, and that means big savings on fuel costs. Nanopore has generated over 80 patents and supplies a wide range of commercial high efficiency insulation products, again creating new job growth in energy technology.

I am also glad that we have with us today Dr. Jerry Simmons, the Co-Director of the Center for Integrated Nanotechnologies (CINT) at Sandia National Laboratories. Dr. Simmons was instrumental in a recent dialogue, organized by my office, with Chinese officials representing solid-state lighting research issues. Our hope is that we can establish a positive collaboration with the Chinese in solid-state lighting research, in order to advance both nation’s goals of deploying clean, efficient energy. The potential market in China is enormous, as are the energy efficiency gains and global environmental benefits, that would be realized through use of this technology.

I am pleased that the Department of Energy is moving forward to act on the technology transfer provisions of the Energy Policy Act of 2005. I am also pleased that Congress passed the Competitiveness bill last week, a bill that Senator Bingaman and I worked very hard on for a couple of years. If implemented properly, it will help us remain competitive in the sciences as we face the new challenges of a global economy.

Senator Bingaman and I have worked together for a long time on the issue of technology transfer from the National Laboratories. The Department is now working on a technology transfer roadmap to determine next steps in improving technology transfer efforts at the laboratories, and I think this hearing will yield some useful information to guide that effort.

Thank you to all the witnesses for your participation today.

STATEMENT OF MARTIN CHAVEZ, MAYOR, ALBUQUERQUE, NM

Mr. CHAVEZ. Mr. Chairman, Senator, thank you so much for being here this morning and allowing me to be here with you. All of New Mexico, by last count all 33 counties, have made contributions to the State. Thursday and Friday of last week, we hosted in this facility mayors, city managers, county officials from all across the State to share best practices as we are experiencing them and learning them in the city of Albuquerque.

It was clear at the conclusion that there's tremendous interest on the part of all communities in New Mexico in doing the right thing, whether it be to address climate change or whether it be in the interest of energy independence or frankly for the creation of wealth in our communities. It was very clear at that time that there was a tremendous need for resources and expertise.

I want to on behalf of all of Albuquerque thank you and commend you for the legislation that has now passed the House and is in conference that would provide block grants to local governments around the State of New Mexico and indeed around the country.

As you're aware, Senator, the Federal administration has been slow on these issues and it has fallen to America's cities to take the lead. Over 600 cities have now signed onto the clean air protocol. We're all very proud of that and we recognize that some things really are best local, whether it be building codes, things of that nature. But some things absolutely cry out for Federal partnership.

So I want to commend you for your leadership. I want to acknowledge as well the leadership of Senator Domenici on behalf of New Mexico and the country. I want to commend as well the President for now acknowledging the climate changes and man-made phenomena, if I'm understanding that that is what he is acknowledging. We have a long ways to go.

Albuquerque might seem to some an unlikely epicenter for the place to have a global sustainability movement. But, in fact, it's because of the inaction at the Federal level that the cities have had the ability to really do the right thing.

We've had some head starts here in great part thanks to Federal legislation. Albuquerque is rated as having the first, second, or third cleanest air of any city in America depending on whose gauge you use. If you utilize mine, it's No. 1 clearly.

That is a function of Federal legislation of the Clean Air Act which has compelled us to engage in certain conduct, whether it be auto emissions checks, things of that nature. We see that at the

end we are a healthier community, indeed the best community in America most recently ranked but also a more productive community. It's simply a better place to do business if the people are healthy, if the air is clean. So we have a number of things that have allowed us to have a step up.

The interface between the building environment in climate change is now very well-known. Depending on the community, between 45 percent and 55 percent of all carbon emissions are generated by buildings, their construction, their operation. We're very proud that a New Mexico architect is the architect of the 2030 plan.

Speaking to this group yesterday was the CEO of Green Build around the country. They have now incorporated lead into 2030—or 2030 into lead, Bill Fradrezzi, and he's doing a great job on this. Again it focuses attention on New Mexico and our communities and the leadership role that we have by virtue of a lot of hard work by a lot of people.

The location of the national laboratories in New Mexico is not an accident. It was because people worked to make it happen. So today we boast the second highest number of Ph.D.'s per capita than any city in America. That means, when you combine that with our natural wind, our natural sunshine, and our built-in gray matter, we are very well situated to be leaders on many, if not, all of the issues that have to be addressed if we are to save the planet.

Albuquerque, of course—and please forgive me if I brag a little bit on my hometown, but it's my job—received a world leadership award in London in November for our water conservation program, beating out all the major cities in the world.

Under the rubric of sustainability which is really what all of this at its most basic element is about has learned how to take limited resources, extend them, build upon them, and in the process create wealth.

I had the distinct privilege of attending a world conference on these issues in January in Paris just as the new figures were being released on the gravity of climate change and how very real it is and how immediate it is. It was clear that they were still skeptical as they are of many of the things that we do, looking to the United States of America for the leadership in technology.

It is also clear to most who spend any serious time with these issues that this is the beginning of a new era, the beginning of an entire new economy that, if we take advantage of, will transform our country. If we don't, we'll condemn our country for generations.

So I want to assure you that you have our full support as we work to pass legislation at the Federal level, partner with local governments, and probably more importantly with the private sector to remove those barriers. It makes no sense to me that the regulatory environment ought to be such that it stifles innovation in these areas.

I have witnessed this in the last few days, because here are many of the technologies with us today that are dedicated to a new spirit of entrepreneurship as they save the planet. It makes no sense that they should be stifled by impediments, particularly regulatory impediments in that endeavor.

I was in China just 2 weeks ago. The topic of climate change was very real. They were informed, the officials that I met with. Interestingly some of the impediments that we have they do not have, some justified, some unjustified, whether it's a means of transmission of energy which can be an obstacle in this country to innovation, whether it be—no matter what the source of the energy is to CAFE standards which we seem to struggle so greatly with in this country.

At some point I believe the market, if it is respected, and it always has to be respected, will simply demand that change. I know, Senator, that Congress feels that demand from the consumers. Certainly the sales in Detroit indicate that they're feeling a little bit of that demand.

Again I want to pledge to you the support of America's cities in your efforts. I want to thank you for your leadership. There is no question in my mind that done properly we can save our planet. We can assure this country of energy independence and in the process become once again the world leaders in technological innovation.

I know, Mr. Chairman, that you share my goal that the center for technological innovation be located right here in New Mexico. Thank you very much.

[The prepared statement of Mr. Chavez follows:]

PREPARED STATEMENT OF MARTIN J. CHAVEZ, MAYOR, ALBUQUERQUE, NM

Thank you for providing Albuquerque with the opportunity to host this hearing on fast tracking of energy and climate change technology. I want to commend Chairman Bingaman in this regard, and Ranking Member Domenici as well for their continuing leadership in this critical area.

My name is Martin J. Chavez. It is a privilege to talk with you about the role of the State, Federal and Local partnership in addressing the urgent challenge of energy innovation and climate change, and the many opportunities generated by a coordinate, pro-active approach in answering the challenge.

CITIES AS EPICENTER FOR INNOVATION

To some, a city like Albuquerque might seem like an unlikely epicenter for the global sustainability movement. But a failure on the part of the present Administration in Washington to take seriously the threats to our environment posed by global climate change has prompted states, and indeed over 600 localities across the country, to step up and rise to the challenge.

And a confluence of circumstances has given communities such as Albuquerque an early opportunity to transform how we live and, by example, be a leader that communities worldwide can look to and learn from.

In terms of clean air, metropolitan areas like Albuquerque got a jump start years before most communities because of our periodic inversion layer. The same recirculation that makes us the hot air ballooning capital of the world, also made it imperative that we greatly reduce emissions.

Today, thanks to emissions testing, particulate mitigation strategies, fuel reformulation, CNG and Hybrid-Electric buses and many other innovations, Albuquerque air is healthy and cleaner than it had been in decades.

But it is worth noting that while the impetus may have come from the grassroots, the authority had to involve federal imperatives such as come from the EPA under an Air Quality Management District. We could not have had the success we have worked so hard for without the federal government as an active and authoritative partner.

NATURAL/BUILT ENVIRONMENT INTERFACE

In terms of the interface between our built and natural environments, Albuquerque today garners a variety of national awards and recognition, from arborists to cyclists and from open space enthusiasts to fitness gurus.

Today's leaders in these areas can point back to the middle of the last century, when Mayor Clyde Tingley built parks, set aside open space and initiated a particularly ambitious tree planting program. We now build on that legacy with initiatives such as the 3000 acre Bosque Restoration Project, renowned trails and open space acquisitions as well as world class sports and cultural amenities. We also recently kicked off a "Million Tree Challenge" by handing out 5000 free saplings to the community.

But again, open space and park land acquisition would have been greatly limited if not for our federal partners. We would not, for example, have the degree of protection we enjoy for the Petroglyph National Monument, or for the Sandias or even the Bosque.

WATER SUSTAINABILITY

And in terms of water sustainability, it was an alarming discovery back in the early 1990s that our aquifer was not nearly so limitless as had been thought, which prompted one of the nation's most ambitious and successful water conservation programs as well as the biggest public works project in the city's history—the San Juan Chama surface water diversion.

Here too, we took the legacy of forethought from those federal, state and local leaders two generations ago who purchased rights to 40,000 acre feet per year of Colorado River water, and we built dramatically upon it. Today Albuquerque boasts not only a sustainable water future on a par with any other major city in America, we actually garnered a World Leadership Award on the subject.

And again, as much as we might have the will, without the federal partnership we all too often lack the ways and means to accomplish our critical environmental goals.

Water makes a great allegory for energy in New Mexico. We have reduced our use by a third, even while we were growing our number of accounts by just about as much. When every level of government comes together as we did over water sustainability, such results should not be unexpected and I believe we can do even better with a similar effort toward energy sustainability. Indeed, it is every bit as imperative that we succeed because our very future depends on it.

ALBUQUERQUE AS HOTBED OF INNOVATION

It should also not come as a surprise to the world that we are a hotbed of innovation, since New Mexico hosts two of the nation's premier energy laboratories as well as major research and development institutions. Even groups that are normally focused elsewhere, such as the National Hydrogen Association, came away impressed with Albuquerque after they chose us as the site for their first Renewables to Hydrogen conference last Fall.

What has become increasingly true about Albuquerque and New Mexico is that the innovations that get their start here are more often sticking around to fruition. We are finally coming into our own as a metroplex capable of hosting the most sophisticated of production operations while attracting, cultivating and retraining the world's most creative minds.

Advent Solar now produces a superior solar cell at the South end of town with a technology that was hatched right here at the federally funded Sandia National Laboratories. And companies such as Eclipse Aviation and Tesla Motors, who could have taken their innovative manufacturing anywhere, have chosen us as well.

MISSING ELEMENTS

But to stay on this path toward sustainability that is economic as well as environmental, we must continue to work the game plan that has brought us here and map out our next moves wisely.

Some key elements to the nascent federal, state and local partnership are still missing.

For one, we lack the resources the federal government can bring to bear. While we now dedicate 3% of our bond revenues to energy conservation and distributed power projects, this amounts only to about \$3 million per cycle. A great down payment, to be sure, but not the kind of resource infusion that is going to sufficiently shrink our carbon footprint or transform our sustainability prospects by itself.

Fortunately, it is our understanding that the critical Energy Block Grants to localities that the Senate sent over to the House have remained whole in that body. So we are optimistic that this element of the partnership may soon be falling into place.

Another area, where we are greatly alarmed, is the lack of CAFÉ standard increases. This is especially embarrassing, when we compare ourselves to the rest of

the world. Even China is putting us to shame in this regard, and it is an area where we are at the mercy of the federal government to set the standard.

While buildings may account for a plurality of greenhouse gas emissions elsewhere in the country, here in New Mexico the number one contributor is transportation. This is partly the result of relatively mild weather shrinking our buildings' emissions somewhat, and also partly due to the fact that we register more miles per year of per capita vehicle travel than most.

This is one area where the localities and states must look almost totally to Washington for leadership.

CONCLUSION

The goal has always been an Albuquerque where our children or grandchildren don't have to leave town to realize their dreams. Thanks to smart planning about sustainability and decisive action, and working thru NGO partners such as the International Council on Local Environmental Initiatives, we are making great gains toward that goal.

And we have learned that action toward sustainability can actually be good for both our economic wealth and our quality of life, and that the two goals support each other when we "push the green envelope." It is also, quite simply, the right thing to do and the greatest moral imperative of our time. Because our grandchildren will either look back to us in this time and celebrate that we had the foresight and will to change course, or they will curse us for what we will have left them.

For those remaining folks who disbelieve the scientific consensus about man's influence on global climate change, I would also just like to add briefly that our present reliance on foreign oil—adding billions of dollars per month to our foreign trade deficit—is something we ought to rethink.

But it is also clear to us that there are some things we cannot do alone, and others where we need a "force multiplier" of a partner in the federal government.

So I would respectfully urge the Committee to stand fast on proposals for block grants to municipalities and to make another run at a serious improvement to our now antiquated CAFE standards.

And I would also invite a review of our sustainability blueprint, which will be posted on the sustainability link from www.cabq.gov once it is finalized.

With that, thank you again Mr. Chairman on behalf of Albuquerque and all of New Mexico, both for what you do in the realm of public service and for giving us this opportunity here today.

The CHAIRMAN. Thank you very much. Again thanks for all your leadership. Let me just ask a couple of questions that occurred to me.

One of the problems we've had historically with trying to promote renewable energy and do a better job with energy efficiency is that in the past, that's been driven by changes in the price of oil and the price of gasoline.

You've seen as the price of oil goes up, everybody gets worried about energy efficiency. When the price of oil drops, everybody moves on to other subjects. So we're not able to sustain a focus on the issue.

My impression is that the concern about climate change is sort of a new element in this debate and in discussion and that that is going to change that going forward; and that just as you made this a priority, your administration, whoever succeeds you, and whoever succeeds me in my job is going to have to make it a priority as well just by virtue of the changed perception of the importance of the issue.

I don't know if that's something that you've focused on or if you have any thoughts about how much this is an issue that is front and center because it's of concern to you or is front and center because it is sort of getting hard wired into our national policy concerns.

Mr. CHAVEZ. Mr. Chairman, it is my opinion that we're standing on a railroad track and there's a train coming straight at us and we have two options. One is to get on the train or be run over by it.

The events, the reality of climate change will compel action. The only real question is whether we will act in time to save the species. As one of our speakers, Terry Tammen, last week who is the principal architect of all of California's green program said this is not about saving the planet. The planet will be fine. The question is whether or not our species will be living on the planet at the time.

So I think all of us simply have to respond. What is impressive about this movement, if you will, is the involvement of the private sector. The private sector sees the economics. Much of this conversation started not with environmentalists but with economists. It brings all parties to the table.

I have seen many skilled legislators in my career. Without sounding too sweet about it, you are one of the most skilled I've ever witnessed. I've watched the difficulty of taking a major piece of energy legislation that is imperative and see it work through the Senate and the House and how difficult it is to have meaningful change.

That cannot be the status quo for the future. Either that or the public will rise up and we're all out of work.

The CHAIRMAN. Let me just ask on one other issue. One of the things that we've always strived for here is to take advantage of the technology developed in our laboratories, move it into the private sector, create jobs, and do a lot of good in the process in addition to the job creation, the economic benefits.

We've got some companies that are on this second panel that are going to talk about how they've done that and been able to take technology that was created either in our laboratories, or with help from the public sector, in some way or another, and gone ahead and succeeded in the private sector with that.

It would seem to me that we've struggled to make this work in New Mexico over a long time. But I would think that we would probably have as good an insight here in New Mexico as to what the factors are that make that occur as anyplace in the country.

I don't know if this is something that you've spent a lot of time on. I know, if you have any thoughts about it you want to express, I would be anxious to hear them.

Mr. CHAVEZ. Thank you, Senator. It's just very clear that we have all of the basic assets. I had a marvelous conversation not long ago with one of the principals of the city of Covington, one of the premier or newest developers in the country. Of course, we're building up all of Mesa del Sol which will be to my mind building a city the right way for the future in a sustainable fashion.

He looked at basic elements, free college tuition. There's not many places in the country where you can go to college for free if you just have a decent grade point average. The number of Ph.D.s, all the technological excellence that's going around, the beautiful environment.

His question to me was, Mayor, with all those assets which are superior to just about any community in the country, why aren't

you doing better as a community? Of course, they see the business opportunity and that's why they're here. So we definitely have the assets.

Why we continue to subsidize an industry when gasoline is \$3 at the pump for that continued behavior when we have the crying need for alternatives and renewables is beyond me. It is simply beyond me.

I believe with your leadership and the leadership of the delegation and frankly with the upcoming elections, because I think all sides are now much better informed on these issues, that we're at the beginning of something great and not the end of something great.

The CHAIRMAN. OK. Thank you again for being here and all your leadership on these issues.

We have a second panel of very distinguished private sector leaders who are going to come and tell us about their particular companies and circumstances and the problems that they have encountered and ways they've overcome them. So again thank you very much, Mayor.

Mr. CHAVEZ. Thank you, Mr. Chairman.

The CHAIRMAN. Why don't we ask the second panel to come up here and I'll introduce everybody and we'll go ahead with their testimony.

While I'm thinking of it, so I don't forget, let me also particularly thank John Epstein for his good work in getting this hearing put together. He works with me on the energy committee there in Washington as well and does a great job on this and a lot of other things. So I very much appreciate that effort and want to acknowledge that.

Let me just start to my left, your right, and go right across. I'll introduce everyone and then just ask for you to each say whatever is on your mind.

Dr. Doug Smith is president of NanoPore here in Albuquerque. We had Doug testify before our finance committee in Washington, a couple months ago, on some of the tax issues related to the business that he's in and very much appreciate that and appreciate him being here again today.

Rusty Schmit who is the founder and president and chief executive officer of Advent Solar which is a very successful company that we're very proud of, it's located here in Albuquerque. He's got a great story to tell and great insights into this issue and so we appreciate him.

Dr. Jerry Simmons who is the program manager for solid state lighting out at Sandia National Labs. Jerry is putting New Mexico and Sandia on the map in this solid state lighting area and it's an area that we think is going to be a growth area for a long, long time.

Dr. Hung Hou who is president and the chief operating officer for EMCORE Corporation that now is headquartered here in Albuquerque. We're very glad that they are. We're very glad that Dr. Hou is here to talk about that and what they're doing.

So, Doug, why don't you start and give us your views and we'll just go across in the order that I've indicated and then I'll have a few questions.

**STATEMENT OF DOUGLAS SMITH, PRESIDENT, NANOPORE
INCORPORATED, ALBUQUERQUE, NM**

Mr. SMITH. Thank you, Mr. Chairman, for the invitation to speak here today. It's probably a bit dangerous to say I can say whatever I have on my mind.

The CHAIRMAN. Go right ahead.

Mr. SMITH. So as background NanoPore has been in business for 14 years here and we now have three different spin-offs and they're all related to not energy production but rather energy efficiency.

We have a brand-new startup called NanoVend which has developed a new kind of vending machine which cuts the amount of energy for vending machines by 80 to 90 percent. We have NanoCool which makes medical packaging which greatly reduces the size and, therefore, the amount of fuel required for air freight for shipping pharmaceuticals.

Our biggest spin-off right now is NanoPore insulation which makes advanced thermal insulation, roughly R-40 per inch. So about seven times better than foam, seven to eight times better than polyurethane foam.

As I testified up in Washington, that's being used now in a number of applications, from refrigerated transport, where we can save 1,000 gallons of diesel per year, to cold storage in everything from McDonald's to large cold storage facilities even getting into housing now.

What I wanted to talk about was really—again we enforce the idea that saving energy is probably the cheapest way to make energy rather than alternative energy. Actually saving it is probably the most efficient way.

But what I really want to talk about is the experience of NanoPore. When I saw about governments working together, I started thinking back to my history. I won't go too far back in my history. I started at—NanoPore is a spin-off of both UNM Sandia.

I ran a center at UNM in engineering and advanced materials. This was a spin-off of that. Sandia was actively involved in that. So we always claim to be a spin-off of both. When our company started 4 years ago, I think of—14 years ago, I think now what would have helped us and would continue to help us.

There are really four issues where government is working together that can talk about tax credits and investment and funding for a change and to talk about what are the practical things, local things that could help us. The first was really technology demonstration projects.

When you come forward with a new technology, whether it's advanced insulation or a new kind of air-conditioning, it's important to get large-scale demonstration projects that have credible analysis of the data. Not me analyzing the data and putting it out, but scientists in the national labs and the university independently monitoring the performance of that.

I think that's an important thing. It's tough for small companies to do when they startup with a new technology. But it really helps give them credibility to have both local governments and State and Federal Governments involved in these kinds of demonstration projects. I think it's a great role for the national labs too.

Another one is really education. Especially when it comes to energy efficiency and energy production, is doing a better job of educating the consumers, even our kids, about the relationship between energy and climate change.

Everybody hears about climate change. But they don't not buy an SUV because of climate change. They may not buy an SUV because of oil prices. So really a better job of education, just like the city of Albuquerque has done on water conservation. So I think there needs to be a combined education effort all the way from the schools up to the Federal level on consumers.

The third is economic development. When NanoPore started 14 years ago, the economic—local economic development activity was essentially nonexistent. Three years ago, when we started NanoCool, one of our spin-offs, we got connected with Albuquerque Economic Development. I have never had such a fantastic experience.

Gary Tonjes and Bob Walton went out of their way to help us. The people who are starting up these days really have it made. But really getting the economic development to focus on these target areas that we want locally to foster.

Finally the fourth thing I think and the most important thing is for governments at all levels to be a good example. I was walking around D.C. recently and walked by the White House. Next to the Executive Office Building there were 20-year-old air-conditioners sticking out of every office window.

It's the most, you know, inefficient way you can think of it. I criticized the Senate when I was there and the vending machines weren't Energy Star rated vending machines. So I think being a good example—you know how it is with your kids. If you don't do something, then your kids aren't going to do it. I think the same thing is going to be true about modifying our energy pattern. With that I'll conclude my testimony.

[The prepared statement of Mr. Smith follows:]

PREPARED STATEMENT OF DOUGLAS SMITH, PRESIDENT, NANOPORE INCORPORATED,
ALBUQUERQUE, NM

Mr. Chairman and Members of the Committee, thank you for inviting me to testify before you today on the subject of reducing barriers to the Growth of Emerging Energy Technologies-Relationships between Federal, State, and Local Governments. Before I begin, I should state that by my way of thinking, emerging energy technologies include both new and improved sources of energy production as well as ways to improve energy efficiency such that we accomplish the same with less energy. This doesn't have to mean that we drive slower or lower the thermostat, just that as a nation, we insert new technologies to reduce our energy consumption. Just from NanoPore and our three New Mexico based spin-offs, we have multiple examples of how this can be accomplished. These include NanoPore Insulation which is the country's largest producer of thermal superinsulation, NanoCool which produces controlled temperature medical packaging which dramatically shrinks package size and hence, reduces air freight fuel consumption, and NanoBev which is producing a new generation of beverage vending which reduces the electricity consumption of vending machines by 80–90%.

We strongly believe that the lowest cost form of new energy generation capacity comes from increasing the efficiency of existing products. In particular, retrofitting insulation to applications originally designed in the era of low cost energy and ignoring the environmental impact of energy use. Although not as sexy as new ways to produce energy, retrofitting older, energy intensive applications has the potential for demonstrating similar energy savings in a much shorter time period and at greater economic and environmental savings to society.

So how can governments at all levels work together to boost the growth of energy technology companies? First, I would start by expanding this group to include our Universities (private and public) as well as our National Laboratories. Before starting NanoPore, I was a professor at the University of New Mexico with strong research ties to Sandia and Los Alamo National Laboratories. That said, I see four areas where government can help to reduce barriers to emerging energy technologies.

1. Technology Demonstration and Validation.—One large barrier to new energy companies is creditability and an unbiased value analysis for their technology whether it is biofuels or advanced electronic controls. Governments are in a unique position to sponsor a range of peer-reviewed, technology demonstration projects for emerging technologies. These serve multiple purposes. As with all new technology, it is often difficult to separate the wheat from the chaff when the market is filled with an array of competing claims. When economic and technical performance is validated by independent sources such as Universities or National Laboratories in well-controlled demonstration projects, the performance data has more creditability in the marketplace and more value in driving energy policy. This builds support from both the customer base and investment community. Because it has been generated by governments, the data can be freely circulated. This approach also helps to connect University and National Laboratory researchers with emerging technology companies. Another benefit is that it helps to build markets for new energy technologies.

2. Education.—As the debate over climate change played out in the media, the consumer has now recognized the importance of climate change but they still do not want to change their behavior. The move to smaller cars from large SUV's is driven more by high oil prices (i.e., market forces) than a concern for the environment. So how does government help? Education is the key to guiding consumer actions to reduce their energy footprint without sacrificing their way of life or receiving an adequate return on their investment. As an example, I suppose that some would say that market forces should govern the use of better thermal insulation and, if the return on investment is adequate, the market will drive the implementation of new technology. My favorite response to this statement is to direct our attention to the hot water heaters we have in our homes. How many of us have gone to Home Depot or Lowe's to buy a insulation blanket for your hot water heater? If our heater is electric, the investment pays for itself in months, not years. Governments, with the support of Universities, National Laboratories, and federal agencies such as DOE and EPA, need to greatly expand education efforts for everyone from young children in school to the elderly consumer. Energy education and awareness is critical to helping to move new energy technology into the marketplace.

3. Economic Development.—As with any new business, a strong local and state economic development team is essential to reduce barriers. When NanoPore started fourteen years, a local economic development team was essentially nonexistent. Three years ago, when contemplating the location of our NanoCool spin-off, the Albuquerque Economic Development team led by Gary Tonjes and Bob Walton were fantastic. They introduced us to a wide range of assistance which made our decision to stay in Albuquerque easy and has allowed us to increase investment and expand. In my experience, it is not enough to just have strong incentives but what is necessary is to have a team that helps guides the technology company through the process of obtaining that assistance. Of course, if economic development efforts are only judged by the number of jobs created that year, it drives development efforts towards companies such as call centers which will create a large number of jobs in a short time and away from helping technology companies which will grow jobs year over year. NanoPore and its joint ventures have grown by 40+% per year for each of the last three years and project at least that rate for the future. Our economic development efforts should be expanded to provide more resources to help focus on areas of longer-term impact and strategic interest for the city.

4. Serve as an Example.—Governments must practice best energy use practices and make the community aware of this. The problem is always the trade-off in initial capital cost and operating costs. Governments should consider energy costs in all of their purchasing decisions whether it is new construction, retrofitting buildings, purchasing equipment, or even sourcing vending machines. Beverage vending machines are a perfect example of how there is often disconnect between the person who pays for the insulation and the person who pays the energy bill. Most vending machines are owned by large beverage/ice cream companies and loaned to the location where the machine is placed. The

store/office/university must pay the energy cost. There are approximately 2 million vending machines in this country and the retrofit application of a 1/4" thick superinsulation would save over 500 MW of energy. This energy savings does not account for the knock-on effect that when energy is being expended inside a building, there is an additional energy load on the HVAC system. Government needs to publicize what it has done to save energy and provide a report card to the consumer. Just as Albuquerque has accomplished with water conservation, we need to use examples and progress reports to show that the Federal, state and city government can save energy (and money) and therefore, the consumer can also.

I would like to thank you for the invitation to speak today and I hope that the information provided will be useful.

The CHAIRMAN. OK. Thank you very much. That's very useful. Rusty, why don't you go right ahead.

STATEMENT OF RUSTY SCHMIT, CO-FOUNDER AND CHIEF EXECUTIVE OFFICER, ADVENT SOLAR, ALBUQUERQUE, NM

Mr. SCHMIT. Thank you, Mr. Chairman, for the opportunity to testify here today. I will keep my opening remarks brief hopefully, but be happy to answer any questions.

For background Advent Solar is a privately funded early stage company. We began operations in July 2003 so we're now 4 years in operation. We have raised 120 million in equity capital and several million dollars more in debt.

So in one sense, as you said in your introduction very graciously, we are successful. But really we've been successful to clarify only in raising money and spending it to get to the next stage. To be a real sustainable business, we have to compete in a global marketplace.

So the target of my remarks today is the barriers in the global industry in which we are living today and what can governments do to model after those other countries' governments in order to promote this kind of industry.

By background as you can see on this first chart on the easel there, the photovoltaic industry in which we are operating is booming. In 2006 the global cell production topped 2.5 gigawatts. As you can see, over the past 10 years, that's an increase of over six X. This is a global industry. The competition that we face is formidable.

All of the leading photovoltaic producing countries have advanced their industries with national energy policies that provide supply and demand in incentives for photovoltaics and other renewable energies and with policies linked to the national energy policy that provide economic development incentives for companies in those fields.

This is not the case yet in the United States despite your leadership in trying to push some of these things through, which I very much appreciate. So I would like to talk about three barriers to companies like ours given this global backdrop.

Like the host countries of our industry leading competitors, the U.S. needs a long-term energy policy that provides incentives for the production and consumption of emerging energy technologies in the U.S. market. This has been highly successful in other countries.

Japan, for example, was the first to provide market incentives for solar electric power as an integral part of their energy policy back in the 1990's. This policy led to tremendous growth in the amount

of solar electricity generated and it also led that country to be a leader in manufacturing of solar photovoltaic products. That industrial leadership continues today, they are the largest manufacturing country of solar PV products in the world.

Though the market demand in Japan has been surpassed now by that in Germany. Germany followed the example of Japan, implemented an incentive program to drive market demand for solar power. Here again it was part of a broader national energy policy for long-term diversification away from traditional coal and nuclear in that country. This market demand in turn led to the buildup of the manufacturing base in Germany.

The second factor is to have open and equal domestic market access. Very simply emerging energy technologies will not emerge if they are easily squashed or obstructed by the bested status quo opponents who fear the loss of their franchise businesses.

Emerging energy technologies in the U.S. need open access to the largest energy market in the world. Our home market is our special advantage. But we need to level the playing field and not handicap newly emerging technologies like solar photovoltaics.

The third factor, Federal, State, and local economic development incentives aligned with national energy policy. Companies such as Advent compete in the global market in which virtually all other countries align their economic development with national policy.

In the solar energy business, we are at a huge disadvantage with our competitors in countries such as Germany because of their grants and other aid provided to companies that locate there.

Germany, for example, has created an estimated 100,000 jobs in the renewable energy field over the past several years. Last year they reported over 35,000 jobs in solar photovoltaics alone. This has driven not only by the market incentives that I mentioned as part of their national energy policy, but also through outright grants from the European Union, the German national government, and the German State governments.

This combination of grants which are linked to job creation often amounts to 50 percent or more of a total project investment. It's very difficult for companies like Advent to compete in this global industry.

To put that in perspective, I mentioned earlier that Advent has raised over 120 million in equity capital. We could have done the same in another country for half of that amount, which is obviously very attractive to investors and makes it much easier to get businesses going and growing quickly.

To summarize, Federal, State, and local economic development efforts should be coordinated through grants or other near-term incentives that lower the barrier to investment for companies involved in strategic new energy technologies.

Again thank you for providing me with this privilege to testify and I'm happy to answer any questions.

[The prepared statement of Mr. Schmit follows:]

PREPARED STATEMENT OF RUSTY SCHMIT, CO-FOUNDER AND CEO, ADVENT SOLAR,
ALBUQUERQUE, NM

Mr. Chairman and distinguished members of the Committee, my name is Rusty Schmit. I am co-founder and CEO of Advent Solar, a solar cell and module manufac-

turing company located in Albuquerque, New Mexico. I would like to thank you for providing me the opportunity to testify before you today.

Advent Solar is a privately funded, early-stage company. We began operations in July, 2003 based on a proprietary "Emitter Wrap Through" solar cell technology licensed from Sandia National Laboratories in Albuquerque, New Mexico. We have raised \$120M in equity capital and \$25M in debt. Today Advent occupies a new 25MW manufacturing facility at Mesa del Sol with close to 200 well-paid employees.

Even though Advent Solar is a U.S.-based company utilizing U.S.-based technology, most of its sales are in Europe, and virtually all of its \$30 million in manufacturing equipment was purchased from industry-leading European equipment vendors. Most of our key raw materials also come from European suppliers.

The photovoltaic (PV) industry is booming. In 2006, global solar cell production topped 2.5GW, a five year increase of 632% from 400MW in 2001. This is a global industry and the global competition is formidable. In 2006, the top PV producing countries or regions were: Japan with a 36% market share; Europe (primarily Germany) with 28%, and China and Taiwan with 22%. The U.S. share of global production totaled 7% (174MW), and a large portion of this was from European and Japanese companies with U.S. operations.

Most industry analysts believe that China will be the world's largest nation PV producer in a very few years. Currently, China exports 95% of its production.

All of the leading PV producing countries have advanced their industries with national energy policies providing supply and demand incentives for PV and other renewable energies and with policies that are intended to promote economic and energy security and environmental goals. This is not the case in the United States.

Just sixty days ago, the 2007 Senate Energy Bill was stripped of its demand incentives providing federal tax credits for prospective residential PV users in the United States. This was an enormous setback for the advancement of the PV industry in the U.S. and for Advent Solar. The PV world was watching with the expectation that the U.S. was on the verge of asserting its market strength and potential, and instead the status quo prevailed.

In its World Energy Outlook 2006, the International Energy Agency (IEA) projects that world electricity demand will double by 2030. That is, whatever the issues are today, multiply them by two over the next 23 years. Just last month, the National Petroleum Council in its report entitled "Facing the Hard Truths about Energy" stated that the world would need 60% more energy by 2030, and that there are accumulating risks to continuing expansion of oil and natural gas production from conventional sources. The report called for increased energy efficiency and for the expansion and diversification of energy resources.

The global and domestic drivers for renewable energy and other emerging energy technologies have never been more vivid, and I do not need to recite them for you. We live with the consequences of our energy policy or lack thereof day in and day out. The quality of life and standard of living for future generations of Americans and global citizens will be impacted by your wisdom and sensibilities as U.S. legislators and policy makers.

With this backdrop, and from the perspective of Advent Solar, I would like to cite three barriers to Emerging Energy Technologies. The issues and contrasting interests may be complex at a micro level, but they are obvious from a perspective on national policy.

Removing barriers will require bold leadership and enlightened public policy with the longterm public interests in mind.

My three observations are simple and straightforward:

A LONG-TERM NATIONAL ENERGY POLICY

Energy is ubiquitous, it is a global commodity; and it is a global industry. As a U.S.-based industry, solar cell and module manufacturing faces enormous global competition and huge barriers to having any footprint at all. If we are to be successful, it will not be solely as an exporter.

Like the host countries of our industry-leading competitors, The U.S. needs a long-term energy policy that provides incentives for the production and consumption of emerging energy technologies in the U.S. market. This has been highly successful in other countries.

Japan was the first to provide market incentives for solar electric power as an integral part of their energy policy to diversify the sources of electric power generation. This policy led to growth in the amount of solar electricity generated, and also led that country to be the leader in manufacturing of solar photovoltaic products. That industrial leadership continues today, even though the market demand in Japan has been far surpassed by that in Germany.

Following the example of Japan, Germany implemented an incentive program to drive market demand for solar power. Here again, it was part of a broader national energy policy for long-term diversification away from a dependence on coal and nuclear. This market demand led to the build-up of the manufacturing base in Germany.

The private and social benefits make a broader-based national energy policy a sure winner for the twenty-first century.

OPEN DOMESTIC MARKETS

Change happens. In fact, it is a hallmark of an advancing and prosperous society. Emerging energy technologies will not emerge if they are easily squashed and obstructed by vested, status quo opponents who fear the loss of franchise and annuity income status. Emerging energy technologies in the U.S. need open access to the largest energy market in the world. Our home base is our special advantage.

We will not grow our domestic manufacturing industry by selling only into foreign markets. China will beat us at that game.

The U.S. needs political leadership and progressive public policy at Federal, State, and Local levels to bridge diverse energy interests and accommodate change.

It is past time to claim our energy independence and get to work.

FEDERAL STATE, AND LOCAL ECONOMIC DEVELOPMENT INCENTIVES ALIGNED WITH THE NATIONAL ENERGY POLICY

Though often called industrial policy and therefore frowned upon in the U.S., the reality is that companies such as Advent Solar compete in a global market. In that global market virtually all other countries align economic development with national policy. In the solar energy business, for example, we are at a huge disadvantage with our competitors in countries such as Germany because of the grants and other aid provided to companies that locate there.

Germany has created an estimated 100,000 jobs in the renewable energy field over the past several years, with over 35,000 jobs reported in solar energy alone last year. This has been driven not only by the market incentives mentioned above, but also through grants from the European Union, the German national government, and often from the German states. This combination of grants, which are linked to job creation, often amounts to 50% or more of the total project investment. It is very difficult for a U.S. company to compete in this global industry with these types of incentives.

The federal, state, and local economic development efforts should be coordinated through grants or other near-term cash incentives to lower the barrier to investment for companies involved in strategic new energy technologies.

Once again, thank you for providing me with the privilege to address this committee. I thank you for your interest and leadership, and I would be pleased to answer your questions.

The CHAIRMAN. Thank you very much. As I said I'll have some questions after we finish hearing from the other two witnesses. Jerry, why don't you go ahead.

STATEMENT OF JERRY A. SIMMONS, JR., PROGRAM MANAGER AND ACTING CO-DIRECTOR, SOLID STATE LIGHTING, SANDIA NATIONAL LABORATORIES, ALBUQUERQUE, NM

Mr. SIMMONS. OK. Senator Bingaman, thank you for this opportunity to testify today on reducing barriers to the growth of emerging energy technologies through relationships between Federal, State, and local governments.

In the time allotted, I think I'm going to point out some existing partnering mechanisms that have worked well from Sandia's perspective. Then I'll suggest a couple of new ideas.

At the Federal level, the National Competitiveness Technology Transfer Act of 1989 was a watershed event for Sandia. It enabled us to enter into cooperative research and development agreements, or CRADAs, with individual companies and to give them licenses to Sandia technology.

This has been a real success. In the past 3 years, Sandia has signed 245 different CRADA agreements with both large and small businesses. The Act also enabled us to establish entrepreneurial leave program. This program allows Sandia scientists to take a 2-year leave of absence to form startup companies and then to return to Sandia employment, if needed.

The safety net increases the number of Sandia scientists willing to try to take this risk to form a startup company. Both EMCORE and Advent Solar had key founding personnel that were Sandia's on entrepreneurial leave. I don't know if Doug also counts that. No. OK.

Another Federal partnering mechanism is the establishment of user facilities. By far the largest of Sandia's many user facilities is the Center for Integrated Nanotechnologies or CINT jointly run by Sandia and Los Alamos National Labs.

CINT is one of five nanoscale science research centers established by the DOE and represents an investment of \$100 million in buildings and state-of-the-art equipment.

Through a web-based proposal process, universities and businesses can come and use CINT equipment and have CINT scientists work collaboratively on their projects with the costs paid for by CINT. It's turning out to be a great success. Over 200 user projects have been undertaken to date.

As you know in October the National Center for Solid State Lighting was established in affiliation with CINT. Solid state lighting is the use of semiconductor LEDs for ultra efficient general illumination and has the potential for enormous energy savings nationwide and worldwide, reductions in total electricity use of up to 10 percent.

This Center For National Solid State Lighting seeks to leverage CINT equipment and expertise to harness nanoscience for revolutionary advances in this new lighting technology.

At this point I think I might echo something that Doug said. There's a saying that a bird in the hand is worth two in the bush. I'd like to coin a new one, which is a kilowatt-hour at the point of consumption is worth two kilowatt-hours at the point of production. So I think conservation plays an important role.

Let's see. At the State level, the Energy Innovation Fund is a recent exciting development. This is a new partnering mechanism. It's in its first year. The fund provided \$2 million for grants in private public partnerships to accelerate innovation for clean energy technologies in New Mexico. The first five projects of the fund were announced last month.

The local level I think from Sandia's perspective is Sandia's science and technology park is a tremendous success. This 250-acre public/private partnership was initiated in 1998. Companies that located in the park gained easy access to Sandia's world class facilities and scientists, while the city and State get new high paying high technology jobs.

The park currently has 24 tenants, 1,500 employees, and \$260 million in investment. So at this point I'd like to suggest a couple of ideas for bold new moves that we might take, new partnering relationships.

First Sandia often finds it difficult to find funds to enter into CRADA activities that otherwise might make sense. The business partner is often unable to pay for Sandia's share of the CRADA activity, while Sandia's internal funds are often restricted from being used for this purpose.

For example, the funds provided by DOE for the National Center For Solid State Lighting are restricted in this way. A solution to this problem might be this establish funds specifically designated for tech transfer and cooperative R&D in the area of emerging technology, emerging energy technology. I believe this could substantially increase CRADA activities.

The second idea that I would like to suggest involves Federal, State, and local government working together. As I mentioned earlier, there are five nanoscale science research centers including CINT located at national labs around the country.

At many of these labs, State, local, and Federal Governments are partnering with businesses to establish truly major new initiatives in emerging energy technologies. They are leveraging the DOE nanoscience center investments.

One example is the Helios Project. The Helios Project is led by Lawrence Berkeley National Lab and leverages their nanoscience center, the Molecular Foundry.

Helios has already received a commitment from British Petroleum for \$500 million over 10 years. They have also recently been promised 125 million from the DOE's Genomes to Life program and \$70 million from the State of California. A similar broad public/private partnership has been formed at Oak Ridge National Labs in Tennessee to establish their bioenergy science center.

So I think we might want to consider whether a similarly bold new major energy initiative might not be established in New Mexico. It could be formed through a Federal, State, and local partnership, have substantial business involvement, and be affiliated with the Center for Innovative Nanotechnologies at both Sandia and Los Alamos.

A focus on solid state lighting and solar photovoltaics would take advantage of the lab's unique expertise in semiconductors and the State's significant semiconductor business activity.

I agree with Mayor Chavez, that Albuquerque and New Mexico have all the ingredients for an initiative in this area.

So, Senator Bingaman, thank you for the opportunity to testify today and for your strong support of solid state lighting and other emerging energy technologies.

Mayor Chavez, thank you for your leadership in the convening of this event.

[The prepared statement of Mr. Simmons follows:]

PREPARED STATEMENT OF JERRY A. SIMMONS, JR., PROGRAM MANAGER AND ACTING CO-DIRECTOR, SOLID STATE LIGHTING, SANDIA NATIONAL LABORATORIES, ALBUQUERQUE, NM

Mr. Chairman, thank you for the opportunity to testify on reducing barriers to the growth of emerging energy technologies through closer and enhanced relationships between federal, state, and local governments, and the role that national laboratories can play. I am Jerry A. Simmons, Jr., Program Manager for Solid State Lighting research and development (R&D) at Sandia National Laboratories (Sandia) and Acting Sandia Co-Director of the U.S. Department of Energy (DOE) Center for

Integrated Nanotechnologies or CINT. Sandia is managed and operated for the DOE by Sandia Corporation, a subsidiary of the Lockheed Martin Corporation.

Sandia is a multiprogram laboratory of DOE, one of the three National Nuclear Security Administration (NNSA) laboratories with research and development responsibility for nuclear weapons. Sandia's job is the design, development, qualification, and certification of nearly all of the non-nuclear subsystems of nuclear weapons. We perform substantial work in programs closely related to nuclear weapons, including intelligence, nonproliferation, and treaty verification technologies. As a multiprogram national laboratory, Sandia also performs a substantial and ever-growing amount of R&D for DOE's energy and science offices, as well as work in national security and homeland security for other agencies when our special capabilities can make significant contributions. This past year, for the first time, the total amount of direct non-nuclear weapons work performed by Sandia grew to be greater than half our total budget. Energy efficiency and renewable energy and supporting technologies such as energy storage will be a rapidly growing area of Sandia's work for the foreseeable future.

I will begin my testimony by describing some Sandia-related examples of what has worked well in nurturing relationships between local, state, and federal government to promote technology transfer. I will then describe what I see as shortcomings or existing needs, as well as efforts that could be made to overcome these obstacles and deepen relationships between government entities at all levels.

Sandia facilitates the use of federal R&D results, facilities, and resources through technology transfer agreements with private industry, universities, and state and local governments. Partnerships are conducted to ensure that national security is protected, U.S. economic interests are promoted, competition (by the national labs) with private industry is prevented, and fairness of opportunity is provided to all.

FEDERAL GOVERNMENT PARTNERING MECHANISMS

The federal government has taken a number of legislative steps to aid in the transfer of national laboratories-developed technologies to U.S. industries. Technology transfer has been a goal of U.S. government policy since the Stevenson-Wydler legislation of 1980. The Bayh-Dole legislation, also enacted in 1980, permitted small businesses to obtain title to inventions developed with government support. For DOE national laboratories, a watershed event occurred with the passing of the National Competitiveness Technology Transfer Act of 1989, which established technology transfer activities as a mission of Government-Owned Contractor-Operated (GOCO) labs such as Sandia. This enabled Sandia to establish and use two major mechanisms for technology transfer, which continue to be used today.

- First, this act enabled the licensing of Sandia-developed technologies to the commercial sector. This includes not only non-exclusive licenses, but exclusive licenses as well. Exclusive licenses are particularly important because the competitive advantage provided can motivate companies to make the investment necessary to bring a given technology into production. The Act also authorized GOCO labs like Sandia to establish Cooperative Research and Development Agreements (CRADAs) with large and small businesses and to make advance agreements on title to inventions resulting from these agreements. Sandia has embraced this mechanism wholeheartedly; in FY04, FY05, and FY06, Sandia signed 245 different CRADAs involving both large and small businesses.
- Second, in another approach to this technology transfer mission, Sandia established the Entrepreneurial Separation to Transfer Technology (ESTT) program, which enables Sandians to take a leave of absence to start up a technology-based business, with the option of returning to employment at Sandia within 2 years. This program is widely considered a success. It enables employees to mitigate their risks in taking the bold move of establishing start-up companies and has resulted in a number of successful start-ups that might otherwise never have happened. In some cases Sandia has become a partner with the company by accepting equity as partial consideration for licensing its technologies.

Two examples that have particular relevance to today's hearing include that of MicroOptical Devices (MODE) and Emcore and that of Advent Solar:

- MODE was founded in 1995 by a group of Sandians who took an entrepreneurial separation leave. MODE was purchased in 1997 by Emcore. Additional Sandia technology was licensed by Emcore, which then established a facility in the Sandia Science and Technology Park. Today that facility employs nearly 500 people, is an anchoring institution in Albuquerque's high-technology business nexus, and last fall moved its global headquarters from New Jersey to the Park.

- A second example is provided by Advent Solar. Founded in 2002, Advent has an exclusive license to three Sandia patents on emitter wrap-through technology. James Gee, Vice President and Chief Technology Officer as well as a founder of Advent, was one of the original Sandia scientists who led work on this technology. He took advantage of Sandia's entrepreneurial separation program to co-found Advent with President and CEO Rusty Schmit. Today Advent employs more than 165 people and is becoming a cornerstone of Albuquerque's high-tech business community.

Sandia has also established more than 30 unique research facilities for use by U.S. industry, universities, academia, other laboratories, state and local governments, and the general scientific community. These user facilities enable businesses, government, and other institutions to access specialized equipment and the expertise developed to satisfy DOE's programmatic needs. These facilities range from the National Solar Thermal Test Facility, which provides experimental engineering data for the design, construction, and operation of unique components and systems in proposed solar thermal electrical plants planned for large-scale power generation (among other testing capabilities), to the Photovoltaic Laboratories, which are designed to accelerate the commercial use of photovoltaic energy systems and aid in understanding and improving the performance of those systems. One of the most important of these user facilities, and certainly the largest, is the recently established Center for Integrated Nanotechnologies (CINT).

In FY 2001 the U.S. Government launched the interagency National Nanotechnology Initiative (NNI) to accelerate the pace of revolutionary discoveries in nanoscale science and engineering and to facilitate the incorporation of these scientific advances into beneficial technologies. As part of the NNI, DOE's Office of Basic Energy Sciences (BES) has established five new Nanoscale Science Research Centers (NSRCs) located at DOE laboratories. These five Centers, each housed in a new laboratory building with new scientific equipment, are BES national user facilities. The capital investment in these Centers is roughly \$100M each. CINT, with a facility in Albuquerque and another one in Los Alamos, is one of the five NSRCs and is jointly operated by Sandia and Los Alamos National Laboratory (Los Alamos). CINT has state-of-the-art facilities staffed by laboratory scientists, post-doctoral fellows, and technical support personnel. The four scientific thrust areas of CINT are Nanophotonics and Optical Nanomaterials; Nanoscale Electronics, Mechanics, and Systems; Soft, Biological and Composite Nanomaterials; and Theory and Simulation of Nanoscale Phenomena. Users can obtain access to CINT capabilities through a peer-reviewed technical proposal for either independent or collaborative research submitted through the web in response to semiannual Calls for User Proposals. Precompetitive research that will be published in the open literature can receive no-fee access to CINT, while proprietary research can be conducted on a cost-recovery basis. CINT and the other NSRCs provide one model for how federally funded nanoscale science research can be pursued jointly with universities and industry. The five NSRCs are now up and running and appear to be a success: CINT alone has already approved and undertaken over 200 user projects, with the in-kind labor of CINT scientists typically valued at ~30K for each project.

CINT and the other NSRCs provide another opportunity for partnering—the establishment of new initiatives, programs, and centers that seek to leverage the substantial investment in the NSRCs made by DOE/BES. I would like to give two examples in this regard: the first is the National Center for Solid State Lighting (NCSSL) headquartered here in Albuquerque and the second is the Helios Project in Berkeley, California.

Solid state lighting refers to the use of light-emitting diodes (LEDs) to provide white light for general illumination in our homes, offices, and stores. It is believed that in the next decade or two, solid state lighting technology will reach energy efficiencies that are ten times as high as incandescent bulbs and twice as high as fluorescent lamps. If solid state lighting at that efficiency were to replace all the incandescent and fluorescent lamps in the nation, the result would be an overall reduction in the nation's electricity use of 10% and a drop in the national electricity bill of up to \$50B. Further, solid state lights do not contain toxic materials like the mercury found in fluorescents. The technology for solid state lighting has been rapidly advancing and products have recently become available that exceed fluorescents in efficiency. However, it is believed that to reach the ultimate efficiency and cost targets of solid state lighting, breakthroughs in understanding the nanoscale science of LED materials will be necessary.

The NCSSL, established in October of 2006, is a virtual research center involving the five DOE NSRCs. Funded by the DOE's Office of Energy Efficiency and Renewable Energy, the NCSSL program seeks to build upon the investments made by the

DOE/BES by performing targeted research in nanotechnology in areas that could increase the efficiency and lower the cost of LED-based lighting. Projects are selected from the five NSRCs by a competitive proposal process. Sandia has been named the Lead Laboratory in the NCSL. With proposals from both Sandia and Los Alamos, CINT captured 5 of the 7 projects awarded (\$3.4M of the \$5M appropriated) in FY06.

This example shows how the emergence of new energy technologies can be aided by leveraging existing investments and expertise, resulting in the creation of something that is greater than the sum of its parts. In this case one part of DOE was leveraging investments made by another part. However, my second example shows that by involving state and local government, it is possible to accomplish something that is more visionary and much larger.

The Helios Project is an emerging research program, based at the University of California-Berkeley and Lawrence Berkeley National Laboratory, that leverages Berkeley's Molecular Foundry, their NSRC equivalent to CINT, as well as their other R&D programs. The Helios Project targets the research and development of new efficient processes to produce transportation fuel from biomass or from solar-energy-driven electrochemistry. Because of the broad and interdisciplinary capabilities necessary for this bold and ambitious goal, the facility is developing an innovative management plan for integrating the efforts of leading scientists and engineers from disparate disciplines into a single large program. Partnerships will be developed with researchers from a broad base: universities, other national laboratories, and industry. Funding for the project will be similarly broad-based: \$500M over 10 years has already been committed by industry (BP, formerly British Petroleum), up to \$70M may be provided by the State of California, and up to \$15M may be provided by private donors. The federal government (through the DOE Office of Basic Energy Sciences) is also playing a key role through the Molecular Foundry and a solar energy research institute and will provide substantial funding. The expectation is that the Helios Project will maximize the innovation and scientific and engineering strengths of its researchers to produce solutions to problems encountered on the route to efficient and scalable solar fuels, on a time scale of five to 20 years.

The Helios Project in California is an excellent example of how new approaches to managing and funding collaborative work can hasten scientific breakthroughs and carry them through to the practical applications that are required to resolve the energy issues facing our nation and our planet. Of course, every state is different, and each state must consider its unique needs, resources, and institutions. Other examples of successful state-federal partnering include the DOE Center for Nanoscale Materials at Argonne National Laboratory in Illinois and the DOE Bio-energy Science Center at Oak Ridge National Laboratory, which leverages \$80M in state and private-sector sources. It might be possible that New Mexico, building on the expertise of CINT and other resources in the state, could undertake an emerging energy initiative project of similarly bold scope.

STATE GOVERNMENT PARTNERING MECHANISMS

Continuing with examples that have worked, Sandia partners with the State of New Mexico in the New Mexico Small Business Assistance (NMSBA) program. In 2000 the New Mexico Legislature enacted a law that is both innovative and unique among all states, enabling Sandia to use a credit against taxes of up to \$1.8M (this year it was increased to \$2.4M at Sandia and a similar program was initiated at Los Alamos) of its NM gross receipts taxes each year to provide technical advice and assistance to New Mexico small businesses. Requests can be made through the web and assistance can take the form of consulting, testing, and accessing Sandia's unique facilities. This program has been quite successful (the following data is cumulative for 2001–2005): returning greater than \$17M in economic growth in NM (combined increase in business revenues and decrease in operating costs) on an investment of \$9M; creating more than 450 jobs at an average salary twice the state's mean salary prior to this program; generating \$13M in new tax revenues; and increasing the investments in NM goods by more than \$8M. Since its creation by the Legislature, NMSBA has assisted over 1500 small New Mexico businesses. By design, the cost of assistance rendered cannot exceed \$10K/company/year in urban communities and \$20K/company/year in rural communities to assure that Sandia will help companies solve difficult technical problems but avoid becoming the R&D arm of the company.

However, to support sustained collaborations with companies entering the emerging new energy technologies market, a different model is needed that allows R&D investments of larger size. Governor Richardson's Energy Innovation Fund, created during the 2007 legislative session, is precisely the kind of program that will help

to incubate new green energy technology businesses in New Mexico. The fund was established with a \$2M appropriation to accelerate innovation for faster commercial adaptation of clean energy technologies in the state. Projects are required to involve partnerships between private and public sectors, with at least one of the principals being a New Mexico entity. Selections of the first five projects in this program were announced by the Governor last month.

LOCAL GOVERNMENT PARTNERING MECHANISMS

Another example of a relationship that has worked very well on the local level is the Sandia Science & Technology Park (SS&TP), a 250-acre technology community located adjacent to Sandia in southeast Albuquerque. The SS&TP is a public/private partnership originally initiated in 1998 by Sandia National Laboratories, Technology Ventures Corporation, and the City of Albuquerque. Today the partnership includes Albuquerque Public Schools, BUILD New Mexico, the New Mexico State Land Office, the Economic Development Administration, the State of New Mexico, Bernalillo County, the Public Service Company of New Mexico, and the Mid-Region Council of Governments. The benefit of the Park to Sandia is that it facilitates joint R & D, technology commercialization, business development, and supplier relations. The benefit to our federal, state, and local governments is that the Park creates jobs—and not just any jobs, but high-paying, technology-based jobs. Companies benefit from their close physical proximity and access to Sandia's world-class technologies, state-of-the-art facilities, and internationally recognized scientists and engineers. The Park is widely recognized for its notable results—24 tenants, 1500 people, and \$260 million of investment. Perhaps an even more important result is that the average annual salary for each job in the Park is \$62,000, compared to \$37,000 for each job in Albuquerque.

EMCORE is a fine example of a successful company at the Park. They built their first facility there in 1998, a 50,000 sf building to house their Photovoltaics Division, a division built on technology that was licensed from Sandia. Over the years they have licensed even more Sandia technologies and they have continued to add facilities and continued to add jobs. They now have over 175,000 sf of space and almost 500 employees at the Park.

IDEAS FOR BOLD MOVES FOR THE FUTURE

I have been discussing some of the partnering and relationship mechanisms that have worked well from Sandia's perspective in reducing barriers to the growth of emerging new high-tech energy technologies. At this point I would like to suggest a few ideas for additional things that might be tried to further encourage the emergence of new energy technology development in New Mexico and in Albuquerque.

FEDERAL

Let me first address the federal level. As we have discussed, CRADAs have been a tremendously successful mechanism for technology transfer. However, it is often the case that a business will have insufficient funds to pay for a 100% funds-in-CRADA; under this agreement, the business would pay laboratory scientists, engineers, technologists, and other laboratory staff to conduct research on their behalf. This is prohibitively expensive, especially for the bold, high-risk, high-payoff research that will be necessary to develop revolutionary new energy technologies to address the daunting energy challenges facing us. In these high-risk cases, it would be greatly advantageous if Sandia and its industrial partner could apply jointly to the government for joint project funding, with an appropriate amount of matching funds provided by the business. However, funding currently available is often restricted so that it cannot be used in this way. For instance, joint projects between labs and businesses cannot be undertaken through funding for the National Center for Solid State Lighting. To further complicate research partnerships with industry, these NCSSL projects are subject to an "exceptional circumstances" determination with respect to Bayh-Dole, making it difficult to grant exclusive licenses to individual businesses. CRADA activity would likely be stimulated if DOE were to provide funding mechanisms specifically for the development and transfer of emerging energy technologies through joint research by labs and industry.

STATE

On the state level, we are extremely fortunate to have a Governor who is taking bold steps to position the state for a leadership role in the energy technologies of the future. New Mexico's Renewable Energy Transmission Authority (RETA) Act, which just took effect last month, establishes the nation's first state-level financing authority dedicated to developing the towers, transmission lines, and other infrastructure that will be needed to carry electricity produced by renewable sources to

consumers in New Mexico and other states. This positions our state to continue to develop its renewable energy source businesses to supply demand throughout the west, raising our economic prosperity.

We should also acknowledge the leadership of the State of New Mexico in the development of an ecosystem for high-performance computing through the implementation of the New Mexico Computing Application Center. This will be a partnership among New Mexico national labs and academic and industrial entities. A total of \$14 million has been committed by the State of New Mexico this year.

We also have two DOE national laboratories here in New Mexico, each with world-class facilities and staff and unique R&D expertise. In addition, we have excellent capabilities in many relevant fields at the University of New Mexico, New Mexico State University, and New Mexico Tech. Together, these assets provide enormous advantages to the State of New Mexico in its pursuit of energy technology leadership. I'd like to mention a couple of ideas to consider.

Of course, if there were to be a Helios-like project established in New Mexico, it would be highly desirable to have strong state participation. By contributing funding to the project, the State of New Mexico could not only add to the size, momentum, and scope of the activity, but also could help set strategic directions that are tailored to the labs' areas of expertise, complementary to existing New Mexico high-tech industry, and in line with the state's strategic goals for its future energy technology economy. Strong state participation is necessary to make this a true partnership and to ensure there is maximum leverage and benefit to all stakeholders. A large local/state/federal joint energy initiative project for New Mexico will be a large undertaking and likely to take some time to initiate. So the time to start discussing this is now. We might want to consider some smaller jump-start activities to get the ball rolling.

One possibility would be to utilize the existing user facility infrastructure—the arrangements for lab visitors, the proposal call and peer review mechanism, etc.—to start a special category of industrial and university user projects at CINT. This would involve a special pot of money set aside for collaborative projects on emerging nanoscience-enabled energy technologies, leveraging DOE's investment in the facilities at the CINT.

A second way in which the state might reduce barriers to emerging energy technologies is to establish an institution modeled after the New York State Energy Research and Development Authority (NYSERDA). NYSERDA is a public benefit corporation created in 1975 by the New York State Legislature. One of the things NYSERDA does is support basic research projects to help New York's businesses and municipalities with their energy-related challenges. Since 1990, they have successfully developed and brought into use more than 170 innovative, energy-efficient, and environmentally friendly products, processes, and services. These R&D activities provide funds to municipalities and emerging businesses for development in areas such as photovoltaics, wind power, electrical grid technologies, improved high-efficiency vehicles and transportation systems, water management and treatment, building envelopes, and solid state lighting. NYSERDA's research budget of roughly \$30M per year is provided by a combination of assessments on intrastate sales by investor-owned electric and gas utilities, voluntary contributions by the New York Power Authority and the Long Island Power Authority, and limited corporate funds. These contributions to New York's economic growth, energy efficiency, and environmental protection come at a cost of only \$0.70 per year for each New York resident. In addition, the gravity and heft of NYSERDA's program has helped attract matching funding; its Energy Efficiency Services program is federally funded and working with over 500 businesses, schools, and municipalities to identify and adopt existing technologies to reduce their energy costs.

It seems to me that if New Mexico plans to be a leader in growing emerging energy technologies, to reduce the consumption of non-renewable resources by New Mexicans, and to safeguard our enchanting southwestern environment, we might do well to consider establishing a similar institution for New Mexico, adapted to our state's own unique needs and conditions. RETA, the Governor's Renewable Energy Transmission Authority is already a major step in this direction. RETA might be expanded in scope and could be made a partnership between DOE and the State's Energy, Minerals, and Natural Resources Department, so as to encompass the area of energy storage, where Sandia has specific capability as manager of DOE's Energy Storage Program.

Another possibility is to broaden the State's Rail Runner initiative by planning for the next generation of high-speed trains using Sandia and Los Alamos expertise in traction, energy storage, and electricity transmission. High-speed trains could link Las Cruces to Santa Fe and extend westward to Grants and Gallup to further catalyze economic growth in the State.

LOCAL

On the local level, I would also like to suggest a couple of ideas. First, I want to commend the Mayor for his leadership in establishing the AlbuquerqueGreen Program. This innovative program has a number of bold components, such as the commitment to make Albuquerque the most bicycle-friendly city in the Southwest, making sure all newly purchased vehicles run on alternative fuels, changing city operations to reduce greenhouse gas emissions by 67%, and promoting the growth of green-tech companies. I would also like to congratulate the Mayor and the City of Albuquerque on winning the Climate Protection Award from the United States Conference of Mayors for this program. Events like this one that raise awareness of the singular importance of energy to the future of Albuquerque, New Mexico, and the nation serve to underscore the Mayor's leadership in this area. It is a very exciting time.

Some additional ideas that the City might consider are both symbolic and practical. (I suspect that many of them may already have been discussed.)

- First, Albuquerque could declare itself as the Energy City of the Future, defining a blueprint for energy-smart neighborhoods and commercial developments such as the "Jefferson Green Project," but going beyond that to incorporate advanced distributed generation, energy conservation, and transportation technologies at the City subdivision-development level. The City might also consider setting targets for incubating emerging energy technology industry within the Rio Grande corridor.
- Second, the City might wish to designate an Energy Czar, reporting directly to the Mayor, who is responsible for developing and implementing this vision of the Energy City of the Future through specific funding mechanisms that blend federal, state and City of Albuquerque resources. The Czar would also serve as the official liaison on energy issues with the State government, the New Mexico Congressional delegation, the state universities, and Sandia and Los Alamos, our two national laboratories. This Energy Czar would serve as a rapid and efficient conduit of communication between these stakeholders and could help to coordinate future bold actions in this arena.
- Third, the City might consider implementing integrated energy efficiency, renewable energy, and distributed generation technology demonstration projects that can be installed at pilot sites like the Sandia Science and Technology Park (SSTP) or Mesa del Sol. These should be high-visibility projects that showcase these technologies in a "real-world" environment and attract national attention to the City's leadership position in energy and the environment, leveraging the expertise at the national labs.

One opportunity currently exists at the SSTP. Sandia, the City of Albuquerque, and the State of New Mexico have been discussing ways to convert the closed landfill in Phase II of the Park into a source of energy. Imagine all of us, including the federal government, working together to create a demonstration project that converts this landfill gas into a heating source for companies at the Park.

Solid state lighting installations in interior public spaces are another possibility. Because solid state lighting has been used mostly as traffic lights or as exterior architectural lighting (e.g., the Empire State Building), an interior installation would be relatively new and likely to attract national attention, if implemented on a sufficient scale. Possible spaces for such a demonstration project are City government offices, the Rail Runner train station, or even the Albuquerque International Sunport.

SUMMARY AND CONCLUSION

Challenges to supporting the growth of emerging energy technologies revolve around establishing good communication between federal, state, and local government entities and incubating strong partnerships to take bold action. Examples of how large partnerships might work are provided by the Helios Project in California and by the New York State's Energy Research and Development Authority. While these initiatives were established in much larger states with considerably greater economic resources, I feel that New Mexico has other advantages—namely, two large national laboratories with great technical expertise, universities with both requirements and interest in energy research and development, an expanding high-technology business climate, and an outstanding commitment to emerging energy technologies on the part of its two Senators, its Governor, and the Mayor of its largest city. Sandia is equally passionate about future energy technologies and stands ready to support this initiative in any way possible. I would also like to invite the Congressional delegation, the Governor, and the Mayor to come and visit the Center

for Integrated Nanotechnologies' Core Facility here in Albuquerque and to learn about the ways we are harnessing nanoscience for future energy technologies.

Mr. Chairman, thank you for your long-standing vision and leadership in introducing legislation to support energy efficiency and renewable energy technologies and for convening this hearing today. Thank you.

The CHAIRMAN. Thank you very much. Dr. Hou, go right ahead.

STATEMENT OF HONG HOU, Ph.D., PRESIDENT AND CHIEF OPERATING OFFICER, EMCORE CORPORATION, ALBUQUERQUE, NM

Mr. HOU. Thank you, Senator and Mr. Chairman, for inviting me to testify on this very important subject. It is important to our country, important to our community. Apparently it is very important throughout the private sector as well.

As you know EMCORE with its headquarters moved to Albuquerque at Sandia Science and Technology Park. We offer a broad portfolio of compound semiconductor based product for broadband and fiber optic telecommunications networks and high efficiency multijunction solar cells and systems for space and terrestrial solar power applications.

Nine years ago EMCORE licensed advanced solar cell technologies from Sandia National Laboratories and National Renewable Energy Laboratory. We successfully commercialized them for a variety of commercial and defense applications.

Today EMCORE is a world leader in high efficiency multijunction solar cells. We utilize the same technology combined with focusing optics to produce concentrated photovoltaics or CPV systems today. We have successfully demonstrated approximately 40 percent conversion efficiency and a 500 X concentrated illumination.

So this technology offers a significant advancement in conversion efficiency over traditional photovoltaic technology with a typical efficiency of six to 20 percent. It is uniquely produced in the United States. So we believe you will be the most competitive solar photovoltaic in the future.

Over the last decade, EMCORE has invested over \$100 million to develop and manufacture this emerging technology here in New Mexico. We have created approximately 500 new jobs in Albuquerque. More than half of the employees in our Albuquerque campus work in the photovoltaic and solar power divisions.

So my comments today are targeted to a segment of the renewable energy industry. That is the fastest growing energy technology in the world; namely, grid connected solar photovoltaic technology. We have observed this growth and believe it is a direct result of the policy driven support mechanism that other countries primarily European countries have established.

So as a producer of advanced and emerging renewal energy technology, we have a unique perspective on the obstacles that needs to be overcome to achieve success. So we have some recommendations in how the government can help. Also we can talk about, you know, how the private sectors like EMCORE can give back.

Also in a perfectly level playing field of energy, we ought to consider the cost of economic, social, and environmental impacts. But we do realize that we need to be economically competitive in renewable energy. So accordingly EMCORE continues to devote substantial resources to develop technologies to enable a new genera-

tion of solar powered systems based on high efficiency concentrated photovoltaics.

We believe this approach will result in the most cost-effective energy derived from solar power. However, no single company is structured to bear all the risks and costs associated with the deploying new energy technologies.

Especially for the emerging concentrated photovoltaic or CPV technology, we're commercializing. There is in our view a "first mover penalty." Due to the emerging nature and the lack of heritage, we are often asked by our customers to guarantee the performance and an even energy saving revenue stream over 20 to 25 years. So this clearly is beyond our capability. It becomes prohibitively difficult to deploy in the United States.

On the other hand, what we have seen in Europe is government sponsored strong incentive mechanisms. Guaranteed electricity purchases as high as 60 cents per kilowatt-hours for 20 to 25 years for solar photovoltaics has provided price surety and risk return for investors. This type of investment is competitive with any other investment options.

So the U.S. in our view needs a similar risk targeted policy to attract investment in emerging technology. There are other financial considerations we can talk about. For example, Jerry talked about and Rusty talked about the consideration of capital grants to mitigate higher cost for first movers, a duration that allows investors to recoup their investments, and financial measurement and control that reduce price support over time as emerging technologies mature and late movers come to market.

An additional first mover penalty is achieving project financing for the first large-scale project. Market acceptance requires heritage. But heritage requires a first mover to provide an acceptable risk profile in project financing. The government backing to lenders and warranty or insurance support are major risk mitigation benefits for the first project.

Beyond the first project, the industry needs Federal as well as State renewable portfolio standards that are achievable and enforceable to permit a sustainable business environment.

So as the mayor talked about, here in Albuquerque we have excellent solar resources. We have Sandia National Labs and world premier energy research institutions, we have EMCORE and Advent Solar and high tech photovoltaic technology companies.

With our tradition to explore renewable energy, we can really mine gold out of the wonderful blue sky with its high direct normal irradiance. The project support from the local government can take the form of access to the land for deployment.

Project support from the State government can take the form of connection to a facility that can use the power generated from the project. Project support from the Federal Government can take the form of a financial support mechanism to the project financier.

As for the long term, cooperation between the State and Federal Government can take the form of renewable portfolio standards that are enforceable.

How can industry contribute? Industry can give back and is anxious to do so in the form of job creation. To talk about EMCORE's history, in the last 9 years, we have created over 500 jobs in Albu-

querque. But in Europe this is already happening related to photovoltaics. Spain reported a net job creation from 2005 to 2010 is over 9,000 for only 350 megawatts of deployment.

The European Photovoltaic Industries Association reports that due to strong feed-in tariff support in Germany for deployment of 750 megawatts of solar photovoltaics, over 20,000 jobs supporting the solar power industry were created in 2006 alone.

This job creation can happen in the U.S. as well with the support for solar photovoltaics. Only our government can recognize that renewable energy is necessary, not just a discretionary good.

I would like to thank the committee and the chairman for providing me the opportunity to testify and deeply appreciate your interest in supporting emerging energy technology development in commercial deployment. Thank you very much.

[The prepared statement of Mr. Hou follows:]

PREPARED STATEMENT OF HONG HOU, PH.D., PRESIDENT AND CHIEF OPERATING OFFICER, EMCORE CORPORATION, ALBUQUERQUE, NM

Thank you, Mr. Chairman and the members of the Committee for inviting me to testify today on a subject that is of great importance to the nation, namely finding pathways for Federal, State and Local governments to enable US companies to accelerate the development and deployment of emerging energy technologies.

My name is Hong Hou, and I am the President and Chief Operating Officer of EMCORE Corporation. EMCORE, with its headquarters located in Sandia Science and Technology Park in Albuquerque, New Mexico, offers a broad portfolio of compound semiconductor-based products for broadband and fiber optic telecommunications networks and high-efficiency, multi-junction solar cells and systems for space and terrestrial solar power applications. Nine years ago, EMCORE licensed advanced solar cell technologies from Sandia National Laboratories and National Renewable Energy Laboratory, and successfully commercialized them for a variety of commercial and defense applications. Today EMCORE is the world leader in high-efficiency multi-junction solar cells. We utilize the same solar cell technology, combined with focusing optics, to produce Concentrator Photovoltaic (CPV) systems. We have successfully demonstrated approximately 40% conversion efficiency under a 500x concentration. This technology offers a significant advancement in conversion efficiency over traditional photovoltaic technologies and is uniquely produced in the United States. We believe it will be the most competitive Solar Photovoltaic technology in the future.

Over the last decade, EMCORE has invested over \$100 million to develop and manufacture this emerging technology here in New Mexico. We have created approximately 500 new jobs in Albuquerque. More than half of the employees in our Albuquerque campus work in our Photovoltaics and Solar Power Divisions.

My comments today are targeted at a segment of the renewable energy industry that is the fastest growing energy technology in the world, Grid Connected Solar Photovoltaic Technology. We have observed this growth and believe it is a direct result of the policy-driven support mechanisms that other countries, principally European, have established.

The U.S. electricity system is built around fossil fuels and this may be true for many years to come unless a more significant shift in gas prices occurs. According to a recent AEO (Annual Energy Outlook) Report, out of 4,100 Billion KWhr power generated in 2006, renewable energy, excluding hydro power, accounts for only 2.7%, and solar power accounts for less than one four-thousandths. So there is plenty of room for improvement. EMCORE's Solar Photovoltaics developments are responding to the market factors of increasing energy costs and worldwide interest in this energy sector. As I mentioned, Grid Connected Solar Photovoltaic Technology is the fastest growing energy technology in the world.

As a producer of advanced and emerging renewable energy technology, we have a unique perspective on the obstacles that need to be overcome to achieve success. We have some recommendations for how government can help, and what EMCORE can give back.

Although, in a perfectly level playing field of energy, we ought to consider the costs of economical, social, and environmental impacts, we recognize that we need to be economically competitive in renewable energy. Accordingly, EMCORE con-

tinues to devote substantial resources to develop the technologies to enable a new generation of solar power systems based on high efficiency concentrating photovoltaics. We believe that this approach will result in the most cost effective energy derived from solar power. However, no single company is structured to bear all of the risks and costs associated with deploying new energy technologies. Especially for the emerging CPV technology we are commercializing, there is, in our view, a “First Mover Penalty.” Due to the emerging nature and lack of heritage, we are often asked by our customers to guarantee the performance and an even energy-selling revenue stream over 20 to 25 years. This becomes almost prohibitively difficult to deploy in the US. What we have seen in Europe is government-sponsored, strong incentive mechanisms. Guaranteed electricity purchases as high as 60 cents per kilowatt-hour for Solar Photovoltaics over 20 to 25 years have provided price surety and risk return for investors competitive with their other investment options. The U.S needs similar risk targeted policy tools to attract investment in emerging technologies. Other key financial considerations are:

- Price surety that allows risk returns competitive with other investment options.
- Consideration for Capital Grants to mitigate higher cost for first movers.
- Duration, which allows investors to recoup their investments.
- Financial measurement and controls that reduce price support over time as emerging technologies mature and late movers come to market.

An additional First Mover Penalty is achieving project financing for the first large-scale project. Market acceptance requires heritage; and heritage requires the First Mover to provide an acceptable risk profile for project financing. Government backing to lenders and warranty backup or insurance support are major risk mitigation benefits for the first project.

Beyond the first project, the industry needs Federal as well as State Renewable Portfolio Standards (RPS) that are achievable and enforceable to permit a sustainable business environment. Large-scale grid connected PV deployments require efforts to overcome regulatory bias in rates which impact technology choices. Public Utility oversight resists cost recovery of capital on renewable energy.

Government agencies can uniquely capture the public value renewable energy; and cooperation between federal, state and local governments can be key to viability of emerging energy technologies.

With these,

- Our technology risk can be reduced by market factors such as higher energy prices, which stimulate private investment in renewable energies,
- Our market risk can be reduced by incentive mechanisms, which provide defined and stable returns for investors, and
- Our execution risk can be reduced when project lenders whose confidence in emerging technologies can be aided by credit enhancements such as loan guarantees or warranty backups.

Here in Albuquerque we have excellent solar resources: Sandia National Labs as a world premier energy research institution, as well as EMCORE and Advent Solar as high-tech photovoltaics technology companies. With our tradition to explore renewable energy, we can mine gold out of the wonderful blue sky with its high direct normal irradiance. Project support from the local government can take the form of access to land for deployment. Project support from the state government can take the form of connection to a facility that can use the power generated from the project. Project support from the Federal government can take the form of a financial support mechanism to the project financier. And for the long term, cooperation between the State and Federal Governments can take the form of Renewable Portfolio Standards that are enforceable.

How can industry contribute? Industry can give back and is anxious to do so, in the form of job creation. In Europe, this is already happening. Spain reports that net job creation from 2005 to 2010 is 9,186 with over 360MW of Solar PV to be installed. The European Photovoltaic Industries Association reports that due to strong feed-in tariff support in Germany for the deployment of 750MW of Solar PV, 18,000 jobs supporting their solar power industry were created in 2006 alone. This job creation can happen in the US as well with support for Solar Photovoltaics.

With cooperation between government agencies, emerging technologies can reach this success. Right here in Albuquerque, innovative technologies are emerging; and sustainable employment can be created here at home.

In summary, policies that encourage local industry development rather than international job creation should be a significant priority. Policies that create surety for investors will enable renewable energy deployment. Finally, simplicity of policy im-

plementation will accelerate the deployment of solar energy, create jobs, and contribute meaningful renewable energy over the long-term. These simple policies are:

- Price and duration surety.
- Financial support to encourage project financing for emerging technologies.
- Enforceable RPS.

Only our government can recognize that Renewable Energy is necessary—not a discretionary good. I would like to thank the committee for providing me the opportunity to testify and deeply appreciate your interest in supporting the emerging energy technology development and commercial deployment.

I am prepared to answer any questions you may have.

The CHAIRMAN. Thank you very much. Thank you all very much for your testimony. Let me just start by asking Doug Smith about your four suggestions.

One of the first was that we, the government, can help with technology demonstration. Can you give us some examples of what you see or an example of what you see that the government could do to help demonstrate some of the technologies that you've developed on a large scale basis?

You indicated that our vending machines in the Senate are out of date. I agree with that. Are there some other things like that that the government could take the lead on demonstrating the cost savings that can be achieved through use of your technology?

Mr. SMITH. Absolutely. I should say some of that is ongoing already. We're working with the EPA smart waves program already on reefer trucks. But again they don't really have much funding to support demonstration programs. They're just trying to actually bring together people in the private sector to do it.

What we were thinking of is much more of a larger scale effort combined with a large pull-through customer such as a large retailer which has a large reefer fleet to have them outfit them and actually collect data independently from, you know, universities or someone who will then they will report all that data back.

A lot of what we do is we generate data on how insulation helps a reefer truck or a refrigerator in your house. But it's much more like the DOE program with domestic refrigerators back in the eighties, where they subsidized the cost of refrigerators that were much more efficient. Then generated the data to show, yes, you really can save that energy over the life cycle of a refrigerator.

The CHAIRMAN. I'm wondering, on the point about how the government can provide an essential help or a service by doing good independent analysis of the data. I guess that could happen not just with government funded projects but even—I mean if you're doing something for Wal-Mart or you're doing something for some commercial entity, your ability to replicate that and to sell it to others depends upon having good independent data on how much has been achieved by virtue of that use of that technology.

Is there a role for government in that even in analyzing the data that's derived from private sector activities?

Mr. SMITH. There is. But it's more difficult to do. We've been trying to do that now. The issue is if I'm let's say at Wal-Mart, I don't really want that data published so my competitors can see that data unless I get something for it.

So if I'm taking all the risk as the first mover, putting the money into the insulation, doing the project, it's really that, why would I want to share that data with my competitors.

The CHAIRMAN. You say there are some examples, though, where the Federal Government has similar needs for this technology which could be properly analyzed and independently reported on.

Mr. SMITH. Absolutely. The military is a perfect example. It has a large number of cold storage facilities around the world, where again it's gotten a lot of public attention recently obviously in warm parts of the world.

The military would be a perfect example of doing some demonstration projects where they could then monitor it also.

The CHAIRMAN. All right. I think that's useful, a useful suggestion.

Rusty, let me just pick up on your point about aligning national energy policy with economic development policy at the State and local level. I think that's a good way to formulate or frame that.

I guess part of what we have—there's a combination of tax provisions plus direct regulatory provisions that sort of create these incentives that are present in some of our other countries, in Europe in particular, and not present here.

Maybe you can elaborate a little more on this feed-in tariff and how that works. I think maybe people aren't entirely familiar with that. That's something that I've just gotten educated about because of your good help over the last year or so.

If you could describe how that works and what kind of tax and how that compares to the tax incentives or lack thereof that we have in this country.

Mr. SCHMIT. I would be happy to, Mr. Chairman. I'll use Germany as an example, in which the German government driven by the concerns about climate change and driven by the population's concerns about an additional nuclear and coal power plants decided that renewable should be a major part of their energy source portfolio.

But in order to do that, they had to overcome the large hurdle of the upfront costs of solar photovoltaic systems. So they implemented a program in which all the ratepayers in the country pay a very, very small additional fee to the utility companies.

The utility companies in turn take that additional money to pay people who generate electricity from solar panels a higher rate than what you would normally pay to the utility company. To put that into—quantify that, typical in U.S. dollars, typical rates that a homeowner pays for their electricity in Germany are about 20 cents per kilowatt hour.

On the contrary, if you put solar panels on your home, the German utilities will pay you on a sliding scale about 60 cents per kilowatt hour for that electricity because that is, in fact, the value to the country for that power. So they're trying to level the playing field for a new emerging technology by providing this market pull of a guaranteed rate for that electricity over some long period of time.

Because that feed-in tariff is then guaranteed, the banks finance the upfront costs and pay back to the homeowners a reasonable amount of years, even in Germany which doesn't have the sunshine that we have here in the Southwest. It makes it financially attractive and solves the need for clean energy in that country.

The CHAIRMAN. Contrast that system you just described with the efforts we're making here to try to provide some tax incentives to encourage use of alternative fuels, use of photovoltaic cells, if you could.

Mr. SCHMIT. Certainly the tax credit that was proposed in as I understood it Senate bill 590 was three or \$3.50 per watt tax credit is an upfront credit to the purchaser of a system.

So if I as a homeowner put in a system and spent \$15,000 for that system, then I would get about one-third to 40 percent of that back in the form of this tax credit. However, that's not immediate. So it still requires the upfront purchase to come out of my pocket.

Then I benefit from the offset to buying electricity. But it's a little bit more cumbersome system. However, we recognize certainly the regulatory environment in this country over all the multitude of utility companies, public and co-ops, is much more difficult to negotiate a feed-in tariff type of program.

But a combination I believe of a renewable portfolio standard in which the Federal Government imposes a certain percentage of every utility company's generation come from renewables with tax credits and other incentives like that to help offset the cost, although not as streamlined as a feed-in tariff, it could provide definitely the market stimulation that we need in this country.

The CHAIRMAN. So one way to look at the renewable portfolio standard, at least as I'm sort of divining from what you're saying, is it's an indirect way to get to the same point as you have with a feed-in tariff.

But it does show by providing much more flexibility to the individual utility as to how they're going to generate that energy from renewable sources. They could do that by changes in the rate structure, they could do that by purchasing the power from someone else who is producing it from renewable sources. They have a lot of ways to meet it. It's less prescriptive than a feed-in tariff would be.

Mr. SCHMIT. That's correct. It allows the market to sort of define the best way to do that. I think a key element to make that successful as you well know, Senator, in this country is in areas that don't have abundant renewable sources, as you said allowing them to buy from others that do.

Creating that mechanism for interstate transmission of renewable energy and allowing that to be part of their renewable portfolio I think is a key mechanism to make that work.

The CHAIRMAN. OK. Do you see the growth in demand for photovoltaic cells in this country growing substantially? I mean the chart, the first chart you put up, and I guess all these charts show how much more usage there is and purchasing there is of photovoltaics in Germany and in Japan than in our own country in real terms, not just relative to the size of our economies, but in real terms.

Do you see that changing or do you see them moving ahead faster than we are still?

Mr. SCHMIT. Yes to both. It is growing in this country. But the other countries are growing much, much faster. One of the points that I was trying to convey in the testimony is that, through the various programs and policies that those countries have put in

place, not only are they solving their energy needs, but they have taken this industry over.

The U.S. led this industry 20 years ago. Today, as you think see on the charts, the U.S. has been growing very slowly. Other countries have been growing very, very quickly, generating many jobs, taking over the industrial leadership as they have in other industries in the past.

The most recent country to come into play is China just over the last two or 3 years. Many new Chinese solar companies are in operation, many of them have actually gone public on the NASDAQ. So it's U.S. investor base that is helping to finance these. That's the sort of thing that we compete with.

The U.S. market is growing. In a normal sense, you might say it's growing healthfully, maybe 30, 40, 50 percent per year. But Germany is growing by almost two X per year.

The CHAIRMAN. Now the growth in this industry in China I presume is a result of the low cost of manufacture that they enjoy in China for everything, whereas the growth in this industry in Germany or in Japan is not driven by the low cost to manufacture but rather by conscious government policy to promote the transition of the economy to more use of this technology, is that a fair statement?

Mr. SCHMIT. That's correct, that is a fair statement.

The CHAIRMAN. Jerry, let me ask you, on some of your good suggestions, could you elaborate a little more. You talked about these public/private projects or partnerships that have evolved or developed around the country around these five nanoscale centers and suggested that we should consider here in New Mexico.

As I understand what you're saying, we should consider a combination solid state lighting and photovoltaic effort; is that right? Can you elaborate on exactly what you have in mind there?

Mr. SIMMONS. I think if we could try to establish something similar to what's been done at some of the other nanoscience centers, that could really be an exciting opportunity for the State and for the two national labs and for the Federal Government.

A lot of the other centers that have been established are looking at alternative fuels or biofuels. We have expertise in that area. But one thing that I think New Mexico has that the other centers don't have is the expertise in semiconductor technology.

So we could fill a very nice gap nationwide in emerging technology in the semiconductor area. Solid state lighting, Sandia is by far the leading national lab in the country in this area. We have partnerships with businesses and with the DOE. I think that we could do something very substantial there.

I think lowering the cost and improving the efficiency of photovoltaics is also an area that we could contribute to. I don't mean to rule out other emerging technology areas. But I think those two stand out as an opportunity.

The CHAIRMAN. What would be needed by way of a structure or collaboration that is not currently existing? I mean it seems to me you have your center for solid state lighting. We have CINT. There are I think you said a couple of hundred projects currently going on at CINT with private entities as I understand it?

Mr. SIMMONS. Most of the projects of CINT are with universities.

The CHAIRMAN. Oh, they are?

Mr. SIMMONS. Yes. So we're trying to grow the projects to increase the number of projects with businesses. They also tend to be rather small in scale.

The performance of the facility will be judged by number of users. The projects tend to be on the order—have value of 20 to 30 K per project. I think the investment needed for major revolutionary advances in emerging energy technology are larger than that.

One opportunity I think is the new America Competes Act that was passed last week through the leadership of yourself and Senator Domenici. That Act proposes that there be—or mandates that there be up to three discovery institutes located at national laboratories that provide up to \$10 million a year for emerging energy technologies.

I think—and it also specifies that this be partnership arrangements with State and local governments and businesses. So I think that could be an outstanding mechanism to get something major started if the community here in New Mexico can pull together and put together a strong proposal in this area.

The CHAIRMAN. In the private sector in this area of solid state lighting, is there a consortium of companies that is working together to advance the technology or are they just independently doing whatever they can do to advance the technology?

Mr. SIMMONS. I would say that there are aspects—that they are cooperating in some ways. There's a body called the Next Generation Lighting Initiative—Industrial Alliance, Next Generation Lighting Industrial Alliance which is working with the DOE to help them shape their solid state lighting program.

They do compete fiercely with one another. So one of the things we've found is when we seek to establish partnerships with companies, if the mechanisms are such that the IP has to be provided to the competitors, then the companies are reluctant to work with us. They feel like their crown jewel secrets might be given up to the competitors.

The CHAIRMAN. Dr. Hou, let me just ask you, I think it's remarkable the technology that you've developed at EMCORE. As you point out, you've got 40 percent efficiency conversion?

Mr. HOU. Yes, and 500 X concentrates, yes.

The CHAIRMAN. Yes. Explain that second part a little better for me. Maybe everybody in the audience understands it. I don't understand it that well. I understand 40 percent efficiency conversion. Tell me about the 500 X concentration.

Mr. HOU. Yes. In that broader category, there's three technology categories for solar photovoltaics. Silicon, that's what Advent Solar is doing. It had a conversion efficiency of typically about 20 percent. The second class is thin film technology, a multi-silicon cadmium telluride, its conversion efficiency about 6 to 9 percent.

Our technology, we use triple junction advanced solar cell originally developed for space applications. But it's too expensive to populate a whole area. So what we do is using cheaper optics to get the light, solar light velocity focusing to a smaller area.

We put our solar cell only at a focal point. But, you know, it essentially would generate the electricity for the whole area of illu-

mination. So that way we can reduce the cost and make the system more cost competitive.

So the 500 X is now significantly in that way. The 40 percent of convergency is, you know, the indirect comparison to the 20 percent generated by silicon.

The CHAIRMAN. So as far as cost per kilowatt hour of electricity produced, is what you can do with your technology in any way competitive with regular photovoltaic technology?

Mr. HOU. Yes. So, for example, the silicon solar panels these days, you know, it costs about \$3.50 to \$4 per kilowatt—per watt. Our technology, you know, we go to the market with about \$3 to 3.25 per watt. So it's more cost competitive.

Per area basis, you know, we generate more power because at a module level we can get about 30 percent conversion efficiency compared to 18 percent conversion efficiency of silicon. So we generate about twice as much power per unit area because of the technology.

The CHAIRMAN. So what is the main market for the technology that you have developed, is it going to always be sort of the high end space technology kinds of applications or I mean can this be used in normal residential/commercial power needs? What is the main market?

Mr. HOU. Senator, this is designed for terrestrial applications and because of the concentration, we have to have the mechanism to follow the satellite. So we have to have the tracking mechanism.

So it's probably not the best use for commercial—for residential application. You don't want to put a sun tracker on your rooftop. But, you know, it's perfect for medium size and large size utility, you know, solar park commercial applications.

The CHAIRMAN. What are the largest applications that are currently operating? Are there some demonstrations of this that are commercial scale?

Mr. HOU. Yes. This is the very dilemma we are facing. This is an emerging technology. So we are the first mover to this technology. Currently the photovoltaics is—probably silicon is the mainstream. Ninety percent of the market is served by silicon solar panels, the other 10 percent is by thin film.

The concentrator photovoltaic is an emerging technology. EMCORE started developing this system about a year and a half ago. It takes some time for the market to accept this technology. In Europe, say in Spain and Italy and Greece, the acceptance is faster. But in the United States we have worked with several companies in the last 18 months to commercialize this technology.

But the barrier we have is always they say point me to a system that has been operating there for 40 years. We don't. This is emerging technology. We don't have the heritage. Then they ask us to bear all the burden, you know, to say, well, you've got to provide a performance bond, performance and service and this and that.

So we already invested tremendously to develop this technology. Now we've got the technology ready. We're facing the barrier to go to the market because, you know, the end users, they're very conservative. This is a new technology, emerging, I don't want to touch it until you cover all the warranties for performance for the next 20, 25 years.

The CHAIRMAN. So Doug's suggestion that the government could play a useful role in supporting the demonstration, that would be applicable to your circumstance?

Mr. HOU. That would be a wonderful idea. You know, this really doesn't need 40 years of demonstration. If we have a solar park, say, established in New Mexico near Albuquerque, if Sandia can be—the leading premier research institution can be a clearing-house, you know, whoever has this technology, they are facing the same or similar dilemma we have, you know, to get in the solar park to validate their performance.

Once the system goes through a full weather cycle, you know, a year, then a lot of issues can surface out and the problem can be fixed and the heritage will be established.

The CHAIRMAN. OK. Very good. All right. I think all this is very useful and very interesting testimony. If any of you have additional points that have occurred to you that we ought to bring out, I'm glad to hear them. Otherwise we'll call it successful.

Let me just advise everybody, I'm told that there's going to be a lunch next door after this hearing, it's going to be at 11:30. So we've got a little time to kill. But I think this has been very useful.

Let me particularly think Jill Halverson for all of her help getting this organized also. She's worked hard, she works with us here in our Albuquerque office, and has worked with Jonathan on getting this hearing organized.

Thank you all very much and we will conclude the hearing with that.

[Whereupon, at 10:20 a.m., the hearing was adjourned.]