

**Statement of Dr. Jerry A. Simmons, Jr.
Solid State Lighting Program Manager and
Acting Co-Director, Center for Integrated Nanotechnologies
Sandia National Laboratories**

**United States Senate
Committee on Energy and Natural Resources**

**Field Hearing in Albuquerque, New Mexico
Aug. 7, 2007**

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Sandia is a multiprogram laboratory operated by Sandia Corporation,
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INTRODUCTION

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 NCSSL. 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). NYSEDA is a public benefit corporation created in 1975 by the New York State Legislature. One of the things NYSEDA 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. NYSEDA'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 NYSEDA'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 SSTEP. 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.