Prepared Statement of
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Chairman Lummis, Ranking Member Swalwell, and members of the Committee, thank you for this opportunity to discuss the importance of the Department of Energy's National Laboratories, and the recent report, *Turning the Page: Reimagining the National Labs in the 21st Century Innovation Economy.*

I am Dan Arvizu, director of the National Renewable Energy Laboratory (NREL) in Golden, Colorado. From the beginning of my career I have been associated with federal research and the National Laboratory system, starting at Bell Telephone Laboratories in 1973 and subsequently transferring to Sandia National Laboratories where I worked for more than 20 years. I have been at NREL for more than 8 years. Over my career, I have held technical staff, management and leadership positions in basic science, applied research and technology development, and in technology transfer. I've also spent time in the private sector, both directing corporate R&D, and running an energy business. I am in my second term on the National Science Board (NSB), with exposure to the vast investment the country makes in the National Science Foundation. I am currently serving as NSB Chairman.

I'm here today to speak to the importance of the DOE National Laboratories from the perspective of my personal professional experience, and also representing that of my colleagues from the National Laboratory Directors Council (NLDC), which is comprised of the directors of the 17 DOE National Laboratories. My first point in this testimony is to assert that history shows, and the aforementioned report acknowledges, the National Laboratories to have created unparalleled value for our nation, and because of this, these unique national assets should be nurtured with robust and continuing investment.

The Value of our National Labs

I am pleased that the report, *Turning the Page: Reimagining the National Labs in the 21st Century Innovation Economy,* has drawn attention to the critical need for federal investment in the kind of high-impact research that transcends that which is conducted by universities, and which can't, or won't, be supported solely by the private sector. I believe I represent the

collective position of my fellow laboratory directors when I say that the National Laboratories comprise as vital a national resource today, as they ever have. Let me explain.

First, DOE laboratories are addressing critical problems in national security, energy technology and fundamental science. Our labs collaborate with academia and with industry to develop and deploy scientific and technological solutions to our national needs.

Specifically:

- They conduct the world's leading research in the physical, chemical, biological and our computer and information sciences, which gives us essential understanding of the world around us;
- They are enabling us to fully utilize our vast domestic energy resources, and are ensuring that America will have an abundant, affordable, clean, and reliable energy future;
- They help protect the nation by keeping our nuclear deterrent reliable and safe, and assist on a global scale by helping prevent the proliferation of weapons of mass destruction.

Second, our National Laboratories are the home of scientific and engineering capabilities that are essential to our nation's continued primacy in science and technology – and that's an invaluable card to play as we compete in a rapidly evolving global economy. We use these capabilities to address long-term national problems, but we also press them into service for nearer-term emergencies, as evidenced by the labs' responses to the Gulf oil spill, to the 9-11 attacks, and the disasters left in the wakes of Hurricane Katrina and Superstorm Sandy.

Third, National Laboratories design, build and operate unique scientific instrumentation and research facilities that serve tens of thousands of scientists and engineers, from both private industry and academia. I'm proud to say that both the facilities and the research staff of our National Laboratories for decades have been, and remain, the envy the world.

And fourth, National Laboratories generate the innovation that contributes to U.S. competitiveness and our future prosperity. We partner with industry to integrate fundamental and applied research to advance a broad range of crucial technologies, thereby enhancing U.S. global competitiveness. Our laboratories continually accomplish this by making key scientific discoveries, demonstrating these discoveries in early prototypes, and working with industry to move these technologies into the marketplace --- and creating high-paying, private-sector jobs along the way.

The "Turning the Page" Report

It's important to note that the "Turning the Page" report reflects many good insights into the value the labs provide. Each section of the report demonstrates respect for the institutions in question, a firm grasp of the key issues we are facing, and a driving commitment to make changes to meet future needs.

The report especially focuses on how the labs spur innovation to enhance national competitiveness. I would agree that's an essential reason the Lab's exist, and it continues to be one of the major benefits the laboratories provide our nation.

It's also important to remember the distinct purposes of our National Laboratories. In the decades since the defense needs of the nation gave birth to the DOE laboratory complex, lab missions have expanded to help solve vexing national challenges. These four missions – national security, science, energy, and environmental management – remain relevant to the nation today, and will remain relevant for the foreseeable future.

For example, if you examine the complex issues revolving around the management of the nuclear weapons stockpile, or addressing the environmental issues from the legacy of past nuclear materials research and production, you will come away with a keen understanding of why National Laboratories continue to work on these challenges.

One area where I and perhaps other Laboratory professionals would agree with the report is its discussion of basic and applied research. The report acknowledges the reality that there's no bright line between basic and applied research. My institution, for instance, the National Renewable Energy Laboratory, is often described as an applied science and technology institution. But in reality, we've learned through more than three decades of successful renewable energy and energy efficiency technology R&D, that there's no dichotomy between pure science and use-driven science. Moreover, what may be considered "applied" research in the lab environment may often be regarded as "basic" research by industry, and deemed out of reach for even the most research-driven companies.

The field of biofuel research today provides a useful example of how this works. Our first forays into turning plants into fuel were based on centuries of making beer and wine – the basic fermenting process that makes alcohol fuels like ethanol from sugars derived from grains. And where we first started with an "Edisonian" trial-and-error approach, today we're reaching back to look at this process at a molecular level, employing electron microscopes, computational thermodynamics, advanced computer simulation and visualization, and other tools to truly

understand the incredibly complex processes at work. Those insights are allowing us to develop new technologies that produce new energy-rich options that have the best traits of fossil fuels like gasoline, but are created using renewable, sustainable and environmentally-benign cellulosic biomass resources, which don't compete with our food supplies.

This is but one of many, many examples throughout the lab complex where fundamental and applied research must work hand-in-hand if we are to achieve our national goals. This truism is confirmed by the fact that three of the leading U.S. solar photovoltaic technologies – today owned by industry leaders General Electric, Dupont and First Solar – each evolved separately from pilot-scale to commercial-readiness by way of a public-private partnership program, which teamed what were then smaller, original-technology start-up companies, with the world-class research expertise and one-of-a-kind facilities of a National Laboratory. Today we have a clearer understanding: When it comes to fundamental science and applied science – each works best when both work together.

That really is drawn into focus when one considers the need to innovate for national competitiveness. National Laboratories are at this center of innovation, stimulating competiveness and industrial growth by reducing the risk of moving new technology into the marketplace. If you want to impact the economy, America's industries, and job creation in the most efficient, effective and quickest ways possible, you can't minimize the crucial role played by applied research working in concert with more fundamental research at our National Laboratories.

The fruits of that research are evident throughout our nation's economy, and have contributed mightily to U.S. competitiveness. Research that began in 1986 into specialized airfoils for wind turbines – and has continued on everything from gearbox design to advanced electronic control systems – has directly enabled turbine manufacturers like General Electric to be world leaders, and wind power to become the leading new source of electrical generation it is today. Even today, the science of aeroelasticity is as relevant to wind power as it is to aerospace.

A National Laboratory also put the jolt in the Chevy Volt. The advanced cathode technology born out the labs is essential to the innovative electric vehicle's power system, and the labs are also at the forefront of research into longer-life, lower-cost Lithium-Ion battery technology that promises to revive the U.S. battery manufacturing industry.

The thin-film solar panel technology employed by the leading U.S. manufacturer, First Solar, was created in a National Laboratory, and continued work with that industry has resulted in an acceleration of new, more efficient, and cost effective technology into the marketplace. Innovation in the labs is focused on solving problems, and it isn't limited to hardware. To

overcome the high infrastructure costs and deep entrenchment of existing resources and technologies typical throughout the energy sector, NREL in particular has been working with the financial community to identify and overcome the financing impediments that have held back otherwise viable renewable technologies. Informed by stakeholders, NREL has been researching the potential of Real Estate Investment Trusts (REIT), Master Limited Partnerships (MLP), asset-backed securities and other liquid vehicles currently available in the market for investment, to be applied to financing renewable energy markets.

Innovations in cholesterol diagnostics, new refrigerants, improved water treatment technologies, biofuels, magnetic levitation technology, nanoscale machines, improved airport security, zero-net-energy building technology, the maturation of light-emitting diode technology, dynamic windows, and thousands of others discoveries, have all come out of our National Laboratories, and have spurred economic expansion and jobs across the United States.

In each of these instances, the technological breakthroughs that have enabled more rapid commercial adoption would not have occurred if left solely to industry. Our industry partners readily and repeatedly tell us this is so. The R&D performed by National Laboratories is larger-scale, longer-term, and higher-risk, than the private sector will undertake. Thus, the rewards are commensurately higher to U.S. competitiveness as a result of the research performed by National Laboratories.

To sustain and further grow this U.S. competitiveness, we agree with the report that by putting more emphasis on technology transfer, DOE could accelerate commercialization of laboratory innovations. Some of the measures being taken by DOE, such as piloting the Agreements for Commercializing Technology, and expanding the Technology User Facility model, would enhance the labs' ability to partner with industry and move lab technologies to the market. Establishing technology transfer expectations and benchmarks is an important performance management signal that Congress can establish for DOE, and that DOE can provide laboratory M&O contractors. In addition, clearer guidance from DOE on greater use of entrepreneurial leave and exchange programs could also improve technology transfer.

As the dialogue around the proper role of National Laboratories continues, we should not lose sight of what is a simple, yet overarching goal: that of ensuring the marketplace actually adopts the advantageous technologies produced by the labs. Our objective must not be to collect novel patents because they look impressive on the wall. Rather, our objective should be to conduct the essential research needed to develop important new technologies, reducing the technical and investment risk to the point where industry can then bring that technology to the marketplace, where it can benefit the nation.

Improving Strategic Planning and Management Systems

The report, correctly in my opinion, discusses the need for long-term, strategic planning for the Department, and the 17 National Laboratories. It discusses DOE's Quadrennial Technology Review, which was completed in 2011, and suggests that concept could be improved through additional coordination between the various funding entities, and an ongoing process to keep its findings up to date.

Encouragingly, the new Secretary of Energy has come into office with a deep understanding of this and other real and perceived shortcomings in the department, and has committed to making improvements to those a hallmark of his tenure.

Secretary Moniz already has laid out an ambitious agenda some of which he has shared in his June 18, 2013, testimony before this committee for reshaping the Department to better meet the nation's needs. I'm pleased to say that forging a new Quadrennial Energy Review process, one that will candidly consider the nation's energy situation, and apply the Department's resources, including the National Labs, to meet those challenges, is one area near the top of his list.

One area heavily mentioned in the report is that of reorganizing the Department for a more effective DOE management structure and process. While I cannot say how the report's recommendations on management structure will be incorporated by the Department, I can see that Secretary Moniz recognizes the need for integrated planning across the Department, which includes strategically using all of the national laboratories.

Optimizing "Government-Owned, Contractor-Operated"

One of the principal conclusions of the report is that the historical model of organizing the National Laboratories, as government-owned, contractor operated entities, or GOCOs, is fundamentally sound, but over time has lapsed into something less effective. The report notes that by having the government own and direct the Labs, and having private contractors operate them and perform the work, the GOCO model would realize the best of both worlds. In this way, contractors could be free to staff the labs with highly specialized technical expertise and utilize the best management practices from business, while the government provides the big-picture mission and ensures funding.

The report notes that over time, those distinct roles of DOE and its contractors have eroded and become blurred. Issues of micromanagement, of the Department fostering burdensome practices, have indeed occurred. It should be noted that the previous Energy Secretary

recognized this very subject, and he and the National Laboratory Directors jointly embarked on a process to identify and streamline burdensome procedures.

To address this for the longer term, what's needed most is not a massive overhaul of the Department, or its relationship with the Laboratories. The concept of having the best lab contractors – whether they are non-profit research institutions, universities, or for-profit corporations – manage the federal government's research facilities remains as an effective a model today, as it was when it was first envisioned.

The Energy Department and the Lab complex should work together to recapture the best elements of the original GOCO model, and adapt those to the today's modern management and system needs. To put that in nutshell: the Department of Energy needs to give the laboratories direction on "what" needs to be done; the laboratories in turn need to be able to decide "how" to do it. Of course, there should be checks and balances in the system with proper accountability by all.

That's doable, I believe, and it's part of broader changes already underway. Secretary Moniz has talked about working with the leadership of the labs in a much more strategic way, where Laboratories have the independence they need, and the Department has the role of guidance and oversight it needs as well.

Evolving Needs Mean Evolving National Laboratories

There are other changes afoot across the Laboratory complex. In recent years, we've seen any number of Lab functions evolve beyond their original charters and purposes, adapting to new realities. If viewed collectively, the National Laboratories have demonstrated remarkable flexibility to meet the nation's new challenges.

With these changes, there is some duplication of capabilities within the complex. We must remember that a portion of that duplicative function is in fact vital to research. History confirms that competition over ideas can drive innovation, producing more technological pathways and better economic options for overcoming a difficult challenge. Regional access requirements and the ability to have independent peer review at the same level of expertise, are additional reasons for maintaining parallel capabilities. However, wherever we can identify ways to streamline the laboratory system to provide the best return to the American taxpayer, we must work with Congress and the Department to do so.

Aligning the research agenda with the needs of U.S. industry is a worthy goal highlighted in the "Turning the Page" report. So is the notion of revisiting the concept of Performance Evaluation and Measurement Plans, or PEMPs. Within the Laboratory system, there are many inconsistencies in how these plans are developed, what they mean, and how they're

administered. The Department, working directly with the Laboratories, should develop a uniform competency stewardship strategy, one that provides universal standards, but at the same time allows the respective funding DOE program office to tailor Lab-specific plans to fit the differing DOE missions and objectives of each individual lab.

Sustained Competency Stewardship of the Laboratories

The inconsistency of funding different labs, and different lab functions, is a systemic problem that must be addressed. Apart from designated user facilities, the reality is that labs often don't receive the funding they need to adequately steward the national capabilities on their campuses. Some labs, and their associated infrastructure within those labs, directly receive so-called "facilities and infrastructure" funds to maintain and safely operate their key research buildings. Others don't – they must tap into various program funds and find other ways to keep their labs running. The result is that there are widely varied cost structures across the National Laboratory system, with some labs unable to capture their actual cost of doing business in any consistent fashion.

This results in inconsistent performance and outcomes across the complex, and it means that industry and universities face considerably higher costs in partnering with the labs in certain fields, as compared with others. To meet the important goal of working with industry to produce real-world innovation, we know we must strive to reduce our costs of doing business. Yet most of our cost of doing business lies in the need to maintain and operate facilities. We need to address the issue of facility funding (potentially through external peer reviewed competency assessments) if we are to get the most from these national assets.

"Reimagining" These National Assets

I was particularly impressed by the operating phrase in the title of the report we are considering here today: "Reimagining the National Labs." In my opinion, that's the right way to think about this issue. Labs already are reimagining themselves to better fit future needs. In many cases, National Laboratories have become more multi-program oriented, and more reliant on integrated systems to achieve their research missions. Labs today are evolving in many of the same directions advocated by the report. You can see this in how the organizational structures, the management systems and the on-the-ground, operational realities of individual laboratories have dramatically changed in recent years.

Finally, I applaud the authors of the "Turning the Page" report for underscoring a very important question, namely: How do we as a nation best marshal our national scientific and engineering resources to surmount the most critical challenges of our time, and remain at the ready to address the uncertain challenges of our future. We should all be gratified that this question is getting the attention it deserves.