Prepared Statement of
Dan Arvizu
Director, National Renewable Energy Laboratory
Golden, CO
May 18, 2006

Mr. Chairman, thank you for this opportunity to discuss the important role the next generation of energy resources and technologies will play in meeting the critical energy needs of our nation. I am the director of the National Renewable Energy Laboratory, the Department of Energy's primary laboratory for research and development of renewable energy and energy efficiency technologies.

Our nation is at a critical juncture. We need to produce considerable amounts of new energy to serve our citizens and keep our economy growing. At the same time we need to reduce our dependence on imported oil and continue to protect our environment.

The fundamental question -- Where will this new energy come from? – has no one answer. The reality is that if we are to solve our energy problems, and meet the phenomenal growth in demand for energy, we must have an energy portfolio that is at once, both smart and diverse. In my view, it is not a matter of nuclear energy versus solar energy, it's not wind power versus new fossil fuel technologies. The answer is that each will have an important place at the table – we will need all of these technologies, and more.

I cannot predict precisely what our energy landscape will look like, say, in 25 years, as technology and markets evolve. But I can say with some confidence that we do need a significant and sustained national energy research program to get us there.

With a vital research and development program working on behalf of our nation, I am optimistic that we will be able to supply all the energy we need – and develop new industries that help grow our economy, *and* further environmental progress – while doing so. Throughout my career in energy research, I have seen time and again just how much a well-directed and properly supported R&D effort can accomplish.

One need look no further than the relatively brief history of our research facility in Golden, Colo. Since our laboratory was founded in 1977 (known then as the Solar Energy Research Institute) the progress made on so many fronts has been nothing short of remarkable. NREL, along with leading academic institutions and corporations throughout the U.S., have demonstrated that focused research can yield valuable new technologies in the near-term, with many collective benefits for society added over the longer term.

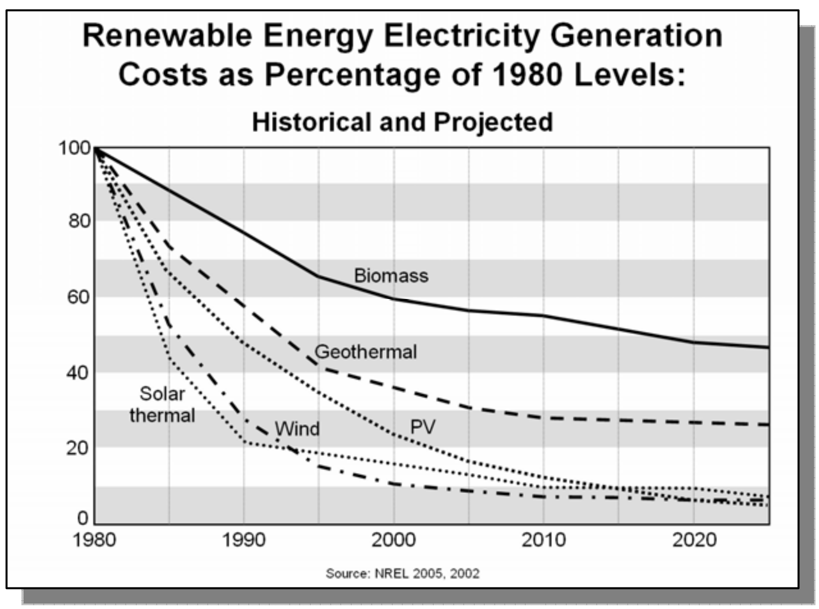
Consider that over the past 25 years, the cost of wind energy has declined from 40 cents per kilowatt-hour to four to six cents a kilowatt-hour today. The cost of electricity from photovoltaic technologies has plummeted 80 percent over that same time. These progressively lower costs have helped wind and solar energy become two of the fastest growing sources of new electricity in the U.S. and the world. Researchers at our laboratory attest to similar gains in other energy technologies, ranging from solar thermal power, biomass power, geothermal energy, hybrid vehicles and a host of advanced energy efficient technologies for industry.

President Bush laid out a timely and compelling energy vision when he came to our laboratory earlier this year. The President's Advanced Energy Initiative calls for a 22 percent increase in clean energy research at the Department of Energy. These proposals emphasize research into renewable fuels, as well as renewable solar and wind technologies.

Renewable energy can and should be one of the key players in meeting future demand for electricity and transportation fuels. We have hugely abundant renewable resources in the United States. The solar resource is good in every state, and even Alaska has the equivalent solar resource of Germany, which today is the largest solar market in the world. There are enough wind resources — concentrated in hilly areas of the country, coastal regions and the Great Plains — to meet twice the country's total electricity demand. There are major, untapped geothermal resources in the West, and you can find vast amounts of useable biomass resources in virtually every state.

Longer term, although hydrogen is often thought of primarily as an automotive fuel, its role as an energy carrier will be important in the electricity sector. Hydrogen can be produced from water using any available source of electricity — fossil, nuclear or renewable. This makes it possible to overcome the intermittency of wind or solar resources by using them to produce and store hydrogen, which can then be used to run a generator on demand.

The challenge that remains before us is to continue to bring down the cost of renewable electricity and fuels in order to accelerate their adoption. NREL and its industry and university partners have made impressive progress in this area over the past three decades but we still have a long way to go before each of the renewable technologies realize their full potential and become truly cost-competitive with traditional alternatives.



Our cost-reduction effort has a two-pronged strategy. One course is to work diligently on short-term, applied R&D to bring down the cost of existing processes and manufacturing methods. The other is to continue with mid-term, disruptive technology advancement, and long-term, higher-risk and revolutionary basic research that industry can't afford on its own, to identify and develop the next generation of renewable energy technologies.

A new, 71,000-square-foot Science & Technology Facility at NREL, to be completed this year, will allow us to do even more of this "transformational" R&D in solar, basic science and hydrogen research.

So exactly where are we today? And, moreover, what remains to be done to ensure that we have the most economic, the most secure and the most environmentally beneficial energy portfolio in the future?

Surely, while we clearly need supply-side solutions, it is equally clear that energy efficiency can be of significant value in reducing the *demand* for power. The goal may be simple – to use energy more intelligently, and not waste it. But achieving that simple goal often requires the same kind of complex and sophisticated concepts and technologies that we have come to expect on the energy production side of the equation.

Energy efficient solutions are often the most cost effective way to meet future demand and also provide additional non-energy benefits, such as improved productivity, increased durability and reduced air emissions.

Buildings account for 70% of the nation's electrical energy use. DOE's current research goal is to develop cost effective, grid-connected Zero Energy Homes by 2020. A net Zero Energy Home produces as much energy as it consumes over the course of year. A total of nearly 40,000 energy efficient homes have been completed within the Building America program, and individual research houses, including the Zero Energy Denver Habitat home, are demonstrating the feasibility of reaching the Zero Energy Home goals. Expanded investments in private and public research partnerships like DOE's Building America Program, are accelerating the adoption of new efficiency and renewable energy technologies within the housing and commercial buildings industries.

Energy efficiency technology also is having a tremendous impact in the transportation sector. DOE's Clean Cities program has encouraged use of alternative fuels, saving more than a billion gallons of oil since its inception. Gasoline-electric hybrid vehicles already are successfully boosting the fuel economy of our nation's vehicle fleet, and plug-in hybrids offer the promise of cars that can go 100 miles or more on a gallon of gas.

It is important that energy efficiency, in combination with energy supply, be a key ingredient of any comprehensive program for national energy research.

On the energy production side, some of the most dramatic cost reductions have been achieved in solar power technology. In real terms, electricity from photovoltaics - or PV, technologies that produce electricity directly from sunlight - cost one fifth or less of what they did 25 years ago. Concentrating solar power costs about one seventh of what it did then. The price of power from grid-connected PV systems today ranges from 15 to 32 cents a kilowatt hour. This year industry will ship PV modules capable of producing 1.2 gigawatts of power into the world marketplace. There is currently 450 megawatts of installed capacity from photovoltaics in the U.S.

Our researchers in the National Center for Photovoltaics at NREL are working to bring that cost down to around 4 to 6 cents a kilowatt hour by 2025. To get there, we will have to develop better, faster and larger scale manufacturing techniques, and create higher efficiency PV panels in the process. Solar technologies have the potential to shift a large proportion of daytime peak loads away from natural-gas-fired generators. And longer term, we believe solar nano-structured materials now being explored at NREL and elsewhere can revolutionize solar PV.

As for wind power, in the best wind regimes, wind-generated electricity today costs about 4 to 6 cents/kWh — one-tenth of what it did 25 years ago. Our engineers and industry partners at the National Wind Technology Center are developing new methods to drive that cost down to 3.6

cents a kilowatt hour at low wind-speed sites onshore by 2012, and down to 5 cents a kilowatt hour for shallow water offshore sites by 2014.

Wind energy is the most mature of the renewable technologies. In some regions, wind power can be the cheapest source of electricity. There currently are 10 gigawatts of wind power installed in the United States, and 60 gigawatts worldwide. While wind power is well established, and is growing at impressive rates, there remains considerable need for new research that will further drive down costs, and, importantly, make this clean, renewable energy source better suited to areas that have lower average wind speeds than the prime areas being developed thus far.

Our work today is focused on developing efficient, low wind-speed turbines, advanced power electronics and transferring wind technology to off-shore systems. If we continue to develop more advanced methods of accurately forecasting and integrating wind into the broader electrical generation system, wind energy has the potential to contribute up to 20 percent of the nation's electricity.

There is 10,400 megawatts of biopower generation in the U.S. Biopower today costs 8 to 12 cents a kilowatt hour, half of what it cost 25 years ago. Scientists at NREL's National Bioenergy Center and other labs are hard at work to lower that figure to 6 to 7 cents a kWh by 2020.

Geothermal resources contribute 2,400 megawatts to the nation's power needs. Electricity from geothermal resources costs 5 to 8 cents a kilowatt hour today – about one-third of the cost 25 years ago. With the technology improvements we see over the next two decades, geothermal power is projected to drop to less than 4 cents a kilowatt hour by 2025.

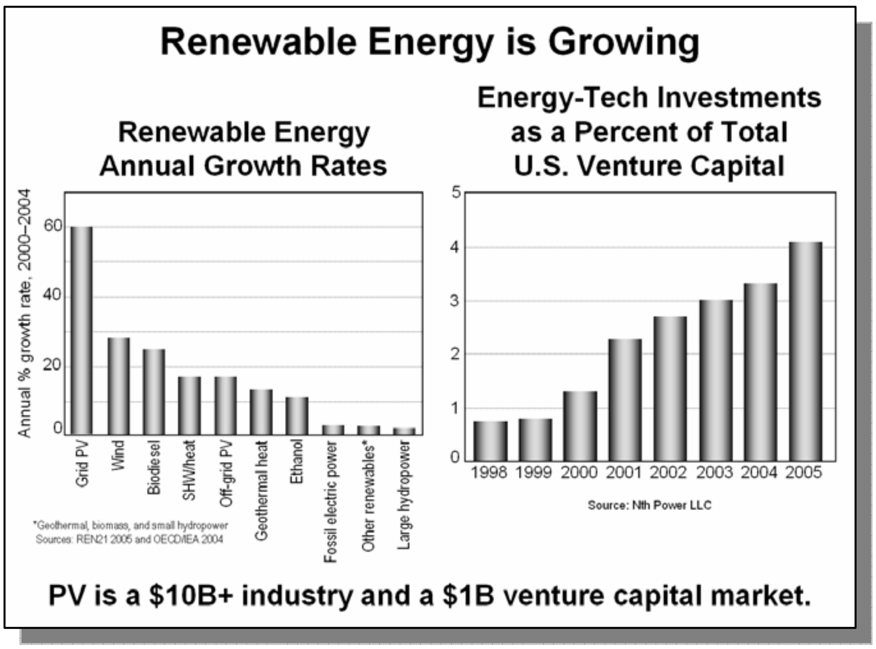
As for ethanol and other fuels made from biomass, there have been significant improvements as well. Whereas the cost of producing ethanol was more than $4 a gallon 25 years ago, it can be made for $1.20 a gallon today. Our nation currently produces about 4 billion gallons of ethanol annually, primarily from corn grain. However, corn comprises but a small fraction of biomass that can be used to make ethanol. A DOE and USDA study suggests that, with aggressive technology developments, biofuels could supply some 60 billion gallons per year – 30% of current U.S. gasoline consumption – in an environmentally responsible manner, and without affecting food production.

To gain greater use of "homegrown" renewable fuels, we will need new technologies that will produce competitively priced ethanol from cellulosic biomass, such as agricultural and forestry residues, municipal wastes, trees and grasses. New technologies like those we are now perfecting at NREL can break those cellulosic materials down into sugars and ferment them into fuel. The President has set a goal of making cellulosic ethanol cost-competitive with corn-based ethanol by 2012, and thereby reducing future U.S. oil consumption.

Essential to the success of each of these emerging technologies is the need to move from a predominantly centralized model of power generation to one that includes flexible, resilient and distributed energy systems. This will require a concerted effort to revamp our electricity infrastructure. By putting in place a more modern and flexible electric distribution system, we will be able to take full advantage of each new electric generation technology, and do so in a way that maximizes their benefits in differing states and regions across the country.

Most renewable power systems are distributed in nature, and thereby can enhance reliability of the electricity grid. Distributed generation can additionally be used instead of transmission and infrastructure expansion, and thus save money for utilities and consumers. Calculating the financial value of these benefits from renewables can be difficult. Renewable systems typically cost more initially, but most have low or no fuel costs, which can go a long way toward mitigating price volatility of more conventional fuels such as natural gas. We have to be able to put a dollar value on these benefits — and we're working on that at NREL.

Leadership provided by DOE, EPA, and national laboratories has helped state agencies encourage the use of renewable energy to help meet air quality goals. Maryland, Texas and New Jersey are incorporating energy efficiency and renewable technologies into their State Implementation Plan (SIP) planning process. In Texas alone, 4 million megawatt-hours of energy efficiency measures have resulted in more than 2,000 tons in NOx emission ozone season reductions. Ozone season NOx reductions achieved through energy efficiency and renewable energy measures in New Jersey are predicted to improve air quality by almost 900 tons/season/year by 2012. Illinois is using air quality improvement as a major driver in building 6 megawatt of new wind and renewable capacity in the state.



Having served on the Secretary of Energy's Coal Council for six years, and having been involved with nuclear issues throughout much of my career, I appreciate the challenges in each of these technology areas. Now, as director of NREL, I can tell you that the pathway to reaching the full potential of energy efficiency and renewable energy is clear and compelling.

Renewable energy and energy efficiency technologies can meet our nation's growing energy demand, largely without pollution or other trade offs. These technologies, however, can only achieve their ultimate potential through a significant and sustained national effort, focused on technology research, development and deployment.

Thank you.