Getting Renewables to the Marketplace

By Ann Spence

A Profile of the National Renewable Energy Laboratory

In 2006, a single visit from President George Bush catapulted the National Renewable Energy Lab from a back-burner research lab into the spotlight of mainstream media. It was a benchmark moment for NREL, where renewable energy was recognized as a growing part of a much needed solution for a domestic energy crisis.

The NREL is the Department of Energy's national laboratory dedicated to the purpose of moving renewable energy and energy efficiency technologies into the marketplace. The role and the goal are to move that technology as quickly as possible.

Since 2006, staff numbers have jumped from 1,100 to 1,800, and NREL plans to add another 400 employees within the next two years. The annual budget jumped by $168.87 million following Bush's visit, and the Obama administration increased NREL's funding by another $192.8 million, giving it a total budget of $521.1 in FY09. Of that, $160 million was used primarily for the lab's own infrastructure development. The operating budget is around $350 million.

Innovation is the mission and objective of NREL, developing new technologies and the next generation of

The NREL's 12 program areas are led by experts in technology management with capabilities that span a wide range of renewable energy technologies:

- Analytic Studies
- Biomass
- Building Technologies
- Distributed Energy
- Federal Energy Management
- Vehicle Technologies
- Geothermal Technologies
- Hydrogen, Fuel Cells and Infrastructure Technologies
- Industrial Technologies
- Solar Energy Technologies
- Weatherization and Intergovernmental
- Wind and Hydropower Technologies

the services and technologies that will be in the marketplace.

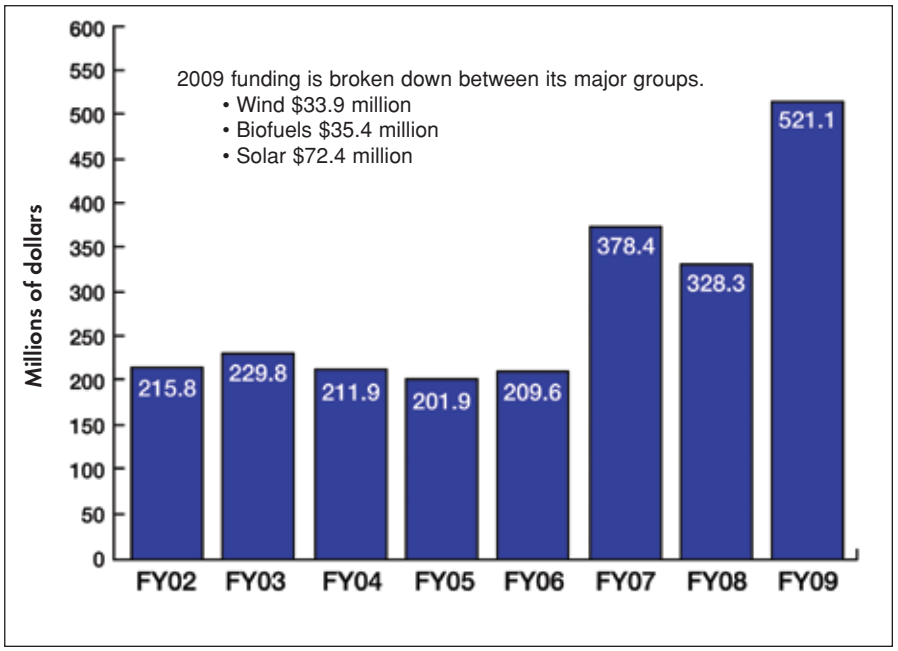
Strategic energy analysis is at the forefront of NREL's mission. This is based on the belief that green jobs are born from market-based solutions rooted in sustainable business opportunities.

It follows that another important mission of NREL is to promote the transition to an energy-efficient and green economy.

NREL is focused on moving technology quickly to get it commercialized. Some of the technologies that began at the concept stage 30 years ago are now today's energy products. But, today, NREL realizes that it can't wait another 30-plus years to get new technologies into the marketplace.

NREL uses what it calls a "speed and scale" approach. The "speed" is moving the innovations, commercialization and the intellectual property. The "scale" has more to do with deployment at commercial scales. The technology must have an impact on a global basis, and it must bear relevance to the challenges the world faces with climate change, energy security and economic prosperity.

The lab's flagship programs are primarily on the supply side. Solar remains NREL's highest-funded department, and the solar and biomass–biofuel programs have gained strong momentum in the marketplace as well as with policy makers. NREL considers both to be integral parts of a solution base for the future.



NREL funding has doubled this decade.

The future is solar

Concentrated solar power

Dan Arvizu, NREL director, is a strong advocate for the development of solar technologies, and he sees it as the technology of the future. His career began in the development of solar power technologies, and he has more than 30 years dedicated to solar advancement. Under his guidance, NREL spends a large portion of resources on concentrated solar power and photovoltaic technologies.

Although Arvizu proclaims solar as the energy source of tomorrow, and he has high hopes for concentrated solar power technologies, he admits there are serious obstacles hindering its advancement. CSP uses mirrors to reflect sunlight onto receivers. Unlike PV cells that directly convert sunlight into electricity, this method uses the sun's heat to drive a generator to produce electricity.

The difficulty with utility-scale CSP projects are their large upfront capital costs. It is a capital-intensive technology. Essentially, it is like buying all the fuel at the beginning of the project. Thus, according to Arvizu, investor confidence and financing issues hold back the technology more than anything.

The good news is that recently there has been very significant public policy, especially coming out of Europe, which has provided encouragement for CSP investors. European projects have been great proving grounds and have provided a lot of experience for the NREL to study. The European experience, according to the NREL, shows that CSP happens to be a great match for central-station power development.

NREL is studying another factor at play overseas. In Spain, for example, feed-in tariffs have provided a tremendous opportunity for CSP to grow.

Feed-in tariffs – FiTs – are the world's most widely used policy to drive renewable energy development. FiTs also have helped transform cloudy Germany into the world leader of installed solar power and photovoltaic manufacturing.

CSP facilities aren't foreign to the U.S. In fact, CSP plants were developed in the mid-1980s in the California deserts, and they are still working today. But since that time, that technology has remained relatively stagnant until recently. Two utility-scale CSP plants have opened since 2007 and NREL now projects that gigawatts of CSP installation will sprout across the U.S.

Nearly $5.5 million in American Recovery and Reinvestment Act funding was recently awarded to NREL's CSP program. Lab officials say the money will be used to establish two new research facilities, and fund testing of new CSP technologies at the Solar Technology Acceleration Center, a new 76-acre test site.

"The CSP industry is growing rapidly and needs DOE's help to evaluate technologies that will make projects more financeable," says CSP program manager Mark Mehos.

"The industry needs performance and durability data in everything from


(Credit: Pat Corkery/NREL)

Mark Mehos, manager of the concentrating solar power program, says much of the ARRA funding for the CSP program will be spent on new facilities to improve thermal storage and other technologies.

materials to systems," he says. "And on the R&D side, these new facilities will help us develop the next generation of materials and systems."

Photovoltaics

According to the NREL, PV technology will likely dominate all other technologies by midcentury, simply because there are so many resources being dedicated to its advancement. The darling of solar energy has always been PV because it's so elegant – the idea of sunlight hitting a semiconductor generating electricity with no moving parts. Of all of the technologies and venture capital, PV is the one investors put the most money into.

The biggest drawback facing PV is price. Materials and manufacturing remain uncostly for wide distribution.

George Douglas, spokesman for NREL, offers a comparison using LCD flat screen TVs. He says LCD technology is the inverse of PV technology: PVs absorb light and make energy while LCDs absorb energy and make light.

"The same materials and care are needed with LCDs as they are with PVs. Imagine acres and acres of LCD screens. There are bound to be technical challenges just in the manufacturing process. Consider maintenance costs. The more efficient the technology becomes, the less materials are necessary, and the more affordable it will get. Once we can get manufacturing costs down, we will have the ability to integrate solar panels all over the world," says Douglas.

The goal is to bring the cost down so that renewables can be competitive with fossil fuels.

No single answer

There is no single energy source of the future, nor should there be. "There is no one single silver bullet," says Douglas. "And there is no reason to think that there should be one single source." Although most research and funding is directed toward solar advancement, biofuels, biomass, wave and tidal energy, nanotechnology and quantum dots show tremendous potential.

"These are exotic, third-generation programs," Douglas says. "There remains the challenge to make them work, and once they do work, to make them affordable options. But they show tremendous potential for the future."

Wind

Much of the wind industry's success can be attributed to the research conducted at NREL's National Wind Technology Center. Funded by the DOE's Wind Energy Technologies Program, research conducted at the NWTC has led to the development of multimegawatt wind turbines that produce electricity at a cost that is starting to compete with conventional energy sources. To make wind energy fully cost competitive and increase wind energy development, researchers at the NWTC are working in partnership with industry to develop larger, more efficient, utility-scale wind turbines for land-based and offshore installations. The center is also working on more efficient, quieter, smaller wind turbines for distributed applications.

Manufacturers, wind plant operators and utilities frequently consult with NREL on wind issues and directly benefit from the lab's research and technical support.


(Credit: NREL)

Concentrated solar power uses mirrors to reflect sunlight onto receivers. NREL's CSP program was recently awarded $5.4 million in Recovery Act funds to further research and development.

Internationally driven

NREL often looks to Spain as a big brother who is one step ahead in the development and application of renewable energy. Energy storage is a major focus of NREL, and geothermal storage holds the most potential. An example of modern thermal storage that the lab is following is the Solar Tres facility under development near Seville by the Spanish engineering company Grupo Sener. Once operational, this 17 MW facility will incorporate 15 hours of thermal storage, giving the facility a 74% utilization factor and the ability to produce 110 GWh annually.

When it comes to deployment of


(Credit: NREL)

Research conducted at NREL's National Wind Technology Center has led to the development of multimegawatt wind turbines.

renewable energy technologies, the U.S. lags behind other industrial countries. Other countries have been driven primarily by heavy government subsidies for solar and wind energy. This has forced some countries, such as Denmark and Germany, to deal with the interconnection challenges that renewables present.

Smart Grid

Still, when it comes to the Smart Grid, there is an even playing field and every nation is facing the same essential challenge.

In the U.S., the NREL monitors state-level public policy (see page 14) and knows that it can bring grid issues to a head. For example, renewable portfolio standards, feed-in tariffs and time-based billing systems are coming forward, often driven by the voters. Meant to spur renewable investments, these policies set in motion changes that demand a different, highly responsive, highly integratable two-way network – the Smart Grid. NREL scientists are making sure that it's coming to fruition.

Of course no one knows for sure what a Smart Grid will look like, but researchers at NREL expect it to be flexible, interactive, less vulnerable than present systems, information-rich and more sophisticated. Today electricity comes from mainly a network of big cables that have central power stations at various intersections. It provides a base load, on top of which varying demand is met. The future grid will be different. Researchers at NREL envision a noncentralized grid that will respond in real time to major and minor fluctuations, transport power far more efficiently and be less vulnerable to natural or deliberate catastrophes.

Today more than 60 percent of the energy content in our supply gets lost in inefficient conversion to electricity at the power plant or on its way to provide a service to the consumer. NREL says this has to be done much more efficiently. For example, the lab suggests that transmission efficiency can be improved over long distances by using a high-voltage direct-current transmission system.

The lab is also working on approaches and technologies for grid of the future that will facilitate the integration of energy produced by solar, wind and other renewable energy sources, or even from personal and commercial-sized fuel cells. The NREL's plans assume these sources will be more widely distributed throughout the country. Its plans also assume that large-scale energy storage systems will have to be major addition to the grid – not only because of cyclical production valleys and phase-shifting problems, but also to permit the pursuit of less-expensive but time-dependent sources of cheap energy.

And, all these pieces have to be tied together in two-way systems. To NREL, this means improved materials, equipment and software that will enable breakthroughs on how energy is bundled, monitored, adjusted and distributed more intelligently while responding fluidly to varying loads.

Finally, a large part of NREL's Smart Grid efforts are aimed at ways to pro-

FiTs versus RPS – collision or compatibility?

Renewable portfolio standards mandates have been adopted in 29 states and Congress is considering a national standard. However, not all of these RPS policies are designed to address the revenue-certainty needs of renewable-energy investors. According to the NREL, that's where Feed-in Tariff programs can be complementary.

"RPS policies tend to set the requirement and let the market figure out how to get there," NREL energy analysts Claire Kreycik says. "FiT policies can help utilities meet their RPS target. It doesn't have to be an either-or choice."

NREL analysts have identified several key factors in a successful FiT policy:

- Stability. Energy projects require several years to develop, so FiTs have to be kept in place five years or longer to encourage certainty with investors and manufacturers.
- Long-term contracts with utility companies, in the range of 15–20 years, allow investors time to recover their costs.
- Adequate energy prices. FiTs must cover project costs, plus a reasonable return to create stability, attract investors, lower risk and keep financing relatively simple.
- Annually decreasing payments. As innovation and growth reduce technology costs, tariffs should be lowered according to a transparent and incremental plan. This encourages rapid deployment and increases competition among manufacturers.
- Payments should be differentiated according to technology type, project size and resource quality.
- Incorporate FiT into the electricity rate base. Tying FiT payments to rate payers distributes costs and provides certainty that investors will get paid.
- Reduce bureaucracy. Streamlining approvals reduces barriers and costs.

tect the power network from physical and cyber attacks.

Soup to nuts

NREL prides itself as being a "soup to nuts lab" overseeing every aspect of renewable energy generation, from concept to large-scale integration into the utility grid.

Regardless, of the field, however, the biggest challenge facing NREL remains the difficult task of having the technology developed quickly, moved into the marketplace and put in place on a scale that makes a global impact.

But one nagging question is, Whose marketplace and who is bringing the goods to market?

Most of the energy technology that's commercially available today was a direct product of the DOE's program years ago, much of which was run through NREL. Yet, for example, most of the leading solar companies aren't U.S. businesses (SunPower, the highest-ranking U.S. solar company comes in only at twelfth in the world).

The irony of that isn't lost on NREL leaders. They acknowledge that international businesses that have taken advantage of past U.S. government research investments in energy. They only wish U.S. companies would do the same, and they stand ready to help them. But they admit that they opportunities are everywhere and everything is up for grabs.

"With the whole impact of global environmental change, we're truly at the pinnacle of a golden age," NREL senior scientist Gary Jorgensen said.

Visit: www.nrel.gov. ■