National Renewable Energy Laboratory
Innovation for Our Energy Future

Energy Innovations
Science & Technology at NREL

Fall 2009

In this issue, we focus on NREL's partnerships with industry and other research institutions.

and more.

Published by the National Renewable Energy Laboratory

NREL Partnerships Garner Three R&D 100 Awards

The power of partnerships is behind some important recent achievements at NREL. In July, *R&D Magazine* awarded its highest honor to products resulting from three NREL collaborations. Although the awardees span different technologies, they share two commonalities: each got its start at NREL and each has the potential to transform its industry.

The 2009 R&D 100 Award recipients are:

Cranking up the Suns Without Cranking up the Heat

One R&D 100 Award went to the Ultra-Accelerated Weathering System (UAWS), a multifaceted, ultraviolet solar concentrator used to speed up the exposure of solar device coatings and other materials to sun and weather. This unique and much-needed capability allows researchers and engineers to see the degradation caused by long-term weathering without having to wait years for results.

This system can expose materials at concentration factors of up to 100 ultraviolet (UV) suns while greatly reducing the heat associated with the visible and near-infrared part of the solar spectrum. Samples therefore maintain relatively cool sample temperatures similar to normal operating conditions. Additional active cooling is also used.

Materials weathered in this manner help researchers and engineers determine the risks associated with development of new products. In addition to solar device coatings, the UAWS can be used to evaluate the durability of paints or finishes used on homes, cars, or bridges.

Technologies are developing and expanding so rapidly, and the competition is so intense, that manufacturers cannot afford to wait for real-time or moderately accelerated test results. Thus, the UAWS is positioned to revolutionize the weathering industry, a market conservatively estimated at $125 million per year.

The UAWS is the culmination of more than 10 years of collaboration between NREL, the Russian Institute of Laser Optical Technology (ILOT), and Atlas Material Testing Technology.

The system was conceived at NREL by Al Lewandowski, Gary Jorgensen, Carl Bingham, and Judy Netter. Vladislav Yampolskiy and Vladimir Kiselev, working in a Russian laboratory at ILOT that was formerly used to develop nuclear weapons, performed further research and delivered a prototype UAWS device to NREL in 1998. The system was refined further via collaboration with Henry K. Hardcastle of Atlas Material Testing Technology, a global leader in weathering testing and equipment. ■

Credit: Joe Poellot/PIX 16581

Members of the Ultra-Accelerated Weathering System team celebrate their recent R&D 100 Award (from left, Henry Hardcastle, Al Lewandowski, Carl Bingham, Gary Jorgensen, and Judy Netter).

> "These achievements would not have been possible without bringing together the theoretical expertise, manufacturing excellence, and application skills represented by this partnership."
>
> **Henry K. Hardcastle,**
> Atlas Material Testing Technology

continued from page 1

A Lighter, More Flexible Parabolic Trough System

Another R&D 100 Award went to a high-efficiency parabolic trough concentrating solar power (CSP) collector for utility-scale solar thermal power plants. Manufactured by SkyFuel, Inc., the SkyTrough™ Parabolic Trough System employs a weatherproof, high-reflectance polymer film developed in a partnership between ReflecTech, Inc. and NREL.

This material, ReflecTech® Mirror Film, replaces traditional glass-based reflectors and makes the entire structure lighter, less expensive, weather-resistant, shatterproof, and easier to maintain. These qualities reduce overall costs of the collector by more than 35%. Such a significant cost reduction will help widen the use of solar-generated electricity in utility markets by addressing primary market barriers—high up-front capital costs and long or low (or both) return on investment.

Pat Corkery/PIX 16464

SkyFuels' Randy Gee and NREL's Gary Jorgensen developed the R&D-100-Award-winning ReflecTech to substitute for bulkier glass mirrors on parabolic troughs.

ReflecTech Mirror Film is the product of years of collaboration between independent researcher Randy Gee and NREL engineer Gary Jorgensen. The U.S. Department of Energy (DOE) cost-shared early research through a $25,000 grant. Over a 10-year period, Gee and Jorgensen worked at encapsulating a very thin layer of highly reflective silver within thin sheets of polymer material. They submitted their invention for patent approval, receiving a jointly awarded patent in 2007.

> "Having the opportunity to work with one of DOE's national laboratories isn't just for large businesses—there are opportunities available for small businesses as well."
>
> **Randy Gee,**
> Chief Technology Officer, SkyFuels, Inc.

Gee is now Chief Technology Officer at SkyFuel, of which ReflecTech, Inc. is a wholly owned subsidiary. SkyFuel holds the exclusive license from NREL for this technology.

Gee says that NREL's wealth of expertise in reflector material research and its state-of-the-art testing facilities attracted him to the partnership. "Having the opportunity to work with one of DOE's national laboratories isn't just for large businesses—there are opportunities available for small businesses as well," he said. "A little money and a lot of hard work and cooperation can go a really long way." ■

A Simplified, Longer Lasting Microbattery

The third R&D 100 Award went to a safe, rechargeable, deep-cycle, thin-film lithium microbattery. The PowerPlane® UX Microbattery is the result of a partnership between NREL and Planar Energy Devices, Inc.

The traditional manufacturing of solid-state batteries involves many process steps, including vacuum deposition, thermal annealing, and encapsulation in hermetic enclosures. NREL researchers Roland Pitts, Ed Tracy, and Dane Gillaspie set out to simplify the process steps and minimize such encapsulation.

They developed a buried-anode architecture, in which the multiple films of the battery are deposited in reverse order in a discharged state, chemically trapping the lithium within the cathode layer. When the battery receives its initial charge, the lithium ions migrate from the cathode and through the electrolyte, forming a layer between the anode current collector and the solid electrolyte layer. Thus, the anode is "buried" under a glass electrolyte and protected by the underlying substrate (typically a metal foil).

> "Planar's roadmap shows an aggressive transformation from traditional storage technologies to a solid-state battery design—and production that will be reminiscent of the semiconductor's transition from vacuum tubes to transistors."
>
> **Scott Farris,**
> CEO, Planar Energy Devices

This patented technology simplifies the manufacturing of durable thin-film batteries, reducing cost and providing long cycle life with less encapsulation than traditional thin-film batteries. The ideal applications for this battery are remote wireless sensors, smart homes, smart cars, and medical sensing devices. Furthermore, the architectural innovation sets the stage for developing process technologies that can lead to solid-state batteries of much larger capacities.

The research that led to this innovative technology was funded in part with seed money from Battelle Ventures in a cooperative research and development agreement (CRADA) with NREL. Later, Battelle Ventures and entrepreneur Scott Farris founded Planar Energy Devices, which is commercializing the technology. ■

Planar Energy Devices/PIX 16588

The PowerPlane® UX Microbattery simplifies manufacturing and requires less packaging than a traditional thin-film battery—and still exhibits long cycle life as well as long shelf life. Applications include remote wireless sensors, smart homes, smart cars, and medical sensing devices.

Telecom Giant Partners with NREL Solar

First came an invention from NREL's Concentrating Photovoltaics (CPV) Group—the inverted metamorphic multijunction (IMM) solar cell, which is engineered to capture energy from a major portion of the solar spectrum and be highly efficient. Then followed an inquiry from RF Micro Devices (RFMD), a telecommunications company looking to take its expertise in mass-producing semiconductor devices and apply it to the solar energy field.

With the signing of a CRADA in April 2009, the match between NREL and RFMD was made. Successful execution of the multi-year CRADA is expected to result in the production of PV cells in RFMD's high-volume compound semiconductor fabrication facilities, as early as 2012, using NREL's IMM technology. This technology won an R&D 100 Award in 2008 and has demonstrated one of the world's highest reported solar cell conversion efficiencies at 40.8%. Continued substantial improvements in efficiency are anticipated.

> **"This entry of the telecom industry into the solar arena is highly significant."**
>
> **Daniel Friedman,**
> NREL CPV Group Manager

"Working with RFMD to commercialize PV cells will help us realize our laboratory's mission of developing and commercializing advanced, next-generation energy technologies," said NREL Director Dan Arvizu.

"RFMD's industry-leading wafer fabrication capability and expertise in commercializing compound semiconductors, combined with NREL's technology leadership and decades of research, uniquely position us to accelerate the commercialization of this next-generation technology," said Bob Bruggeworth, president and CEO of RFMD.

The CRADA will be accomplished in three phases:

1. A foundation phase to establish the capability to manufacture basic PV cells at RFMD's wafer fabrication facilities (fabs)
2. A technology-demonstration phase during which PV cells using NREL's technology will be fabricated at RFMD's fabs
3. A production-readiness phase during which the manufacturing of high-performance PV cells with high yields, high reliability, high reproducibility, and low cost at RFMD's fabs will be established.

During the CRADA, technical representatives from the two organizations will collaborate at NREL and in RFMD's facilities in Greensboro, North Carolina. Six RFMD engineers recently concluded a two-day working visit to NREL's research campus.

"This entry of the telecom industry into the solar arena is highly significant," said Daniel Friedman, manager of NREL's CPV Group. "RFMD is the world's largest manufacturer of compound semiconductor materials, shipping an average of two million devices a day. This level of production is exactly what the solar industry needs to bring down costs and accelerate the pace of moving technologies to the marketplace."

RFMD/PIX 16598

Bob Bruggeworth (left), president and CEO of RFMD, and Dan Arvizu, director of NREL, met recently at RFMD headquarters in Greensboro, North Carolina, to seal a pact between the two organizations. The goal of RFMD's work is to mass produce solar cells based on NREL's award-winning inverted metamorphic multijunction technology.

NREL Principal Scientist Mark Wanlass, inventor of the IMM cell, is the CRADA's principal investigator. RFMD is recognized for its diverse portfolio of semiconductor technologies and systems expertise; it is a preferred supplier to the world's leading mobile device, customer premises, and communications equipment providers. ■

New Partnership with RES Americas "Cemented"

The normally peaceful environment of NREL's National Wind Technology Center (NWTC) just south of Boulder was disrupted in July with the pouring of a *little* cement—about 90 truckloads of it. A parade of trucks dumped tons of cement over an intricate rebar system to form the foundations for two multimegawatt turbines.

The foundations were designed by RES Americas, a developer of U.S. wind farms. They are the center of a CRADA between NREL and RES to study the structural loads on foundations of operating wind turbines, thermal performance of underground collection system electrical cables, and side-by-side comparisons of alternative wind speed measurement systems. The CRADA, worth almost $500,000 over the next two years, will help wind energy researchers better define design margins for specific wind turbine balance-of-plant components to help increase wind plant performance and lower the cost of energy. According to Jim Green, senior project lead at the NWTC, "This CRADA will result in some of the first-ever measurements of loads inside and under the foundation of an operating wind turbine." ■

Whole Foods Market/PIX 16423

Whole Foods is just one retailer working with NREL to reduce commercial building energy use.

NREL Expertise Makes a Business Case for Better Buildings

Twenty-three large businesses are taking a new look at the impact of building energy use on the bottom line. Big names such as Best Buy, John Deere, Kohl's, Toyota, and Whole Foods are participating in "National Accounts," a research project focused on developing next-generation prototype buildings that save energy and are cost effective to build and operate.

The private-sector partners (retailers, real estate management companies, and a distribution facility provider) are working with NREL, DOE, and Pacific Northwest National Laboratory to reduce energy use in commercial buildings.

"This program is unique because it involves the energy end-users," explained NREL Senior Engineer Paul Torcellini. "Using a flipped model, we are engaging energy consumers from a business point of view."

NREL provides technical assistance to help National Accounts companies build new facilities that use 50% less energy and retrofit older buildings to use 30% less energy. Assistance includes energy modeling, developing integrated design processes, energy performance verification, and documentation.

The project is part of DOE's Net-Zero Energy Commercial Building Initiative, which is working to achieve marketable net-zero energy commercial buildings by 2025. Net-zero energy buildings produce as much energy as they use over the course of a year by reducing energy loads through efficiency measures and using renewable energy to meet the reduced loads.

To learn more about National Accounts and view a full list of participating companies, visit www.nrel.gov/buildings/national-accounts. ■

Working with NREL

There are many opportunities and ways to partner with NREL. Learn more about technology partnership agreements and services such as CRADAs, licensing agreements, technology partnerships, and work for others agreements at www.nrel.gov/technologytransfer. ■

Keeping it Cool to Improve Hybrid and Electric Vehicles

NREL is working with the automotive industry to evaluate and develop materials that help cool power electronics in advanced vehicles. NREL has been working with industry suppliers such as GM, Ford, Delphi, Semikron, and UQM as well as thermal interface materials (TIM) vendors to assess the performance of various materials including thermal greases, phase change materials, carbon nanotubes, and thermal epoxies.

Effective TIMs are particularly crucial to keeping inverter components cool. Electric and hybrid electric vehicles use power electronics to condition electrical power between the DC battery and AC motor. Keeping the power electronics as cool as possible can improve performance, reduce stresses, and allow increased power density. As such, inverters can be made smaller, lighter, and

Photo Credit: Pat Corkery/PIX 16582

NREL's Sreekant Narumanchi watches the progress of temperature and pressure tests on materials used in hybrid automobile microelectronics.

cheaper. Critical links are at interfaces between material layers within the power electronics package, made up of a silicon chip, substrate, baseplate, and heat sink. Reducing resistance to heat transfer through just one interface can have a significant impact.

New Thermal Interface Materials on the Horizon

NREL researcher Sreekant Narumanchi and colleagues have helped several inverter manufacturers with their selection of TIMs. In addition, NREL has used test data to help TIMs manufacturers improve their products. Current research includes a novel sintered bond based on silver nanoparticles developed by Virginia Polytechic Institute (Blacksburg, Virginia) that has performed well.

NREL is also testing a new material in partnership with Btech, a small company based in Niwot, Colorado. Under the collaboration with Btech, NREL tested their novel polyamide thermoplastic with embedded carbon fibers. The thermal

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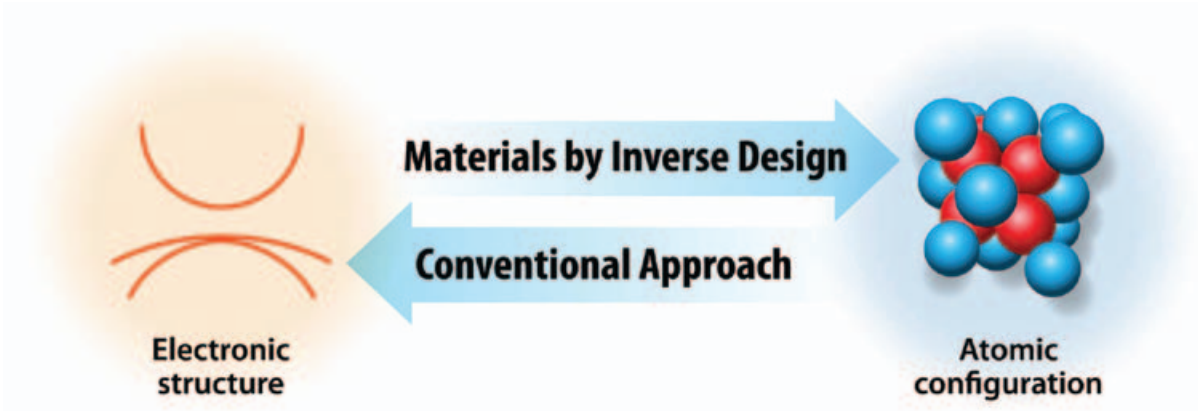


Illustration of the conventional approach to developing new materials for PV versus the "quantum jeopardy" approach used by NREL's Center for Inverse Design, a new Energy Frontier Research Center of DOE's Office of Science.

Quantum Jeopardy — New NREL-Led Research Center Could Reverse the Way Science is Done

Traditional science says: "Give me the structure; I'll find the properties." At NREL, the newly formed Center for Inverse Design wants to reverse this norm. Its approach is "If these are the properties we want, we'll find the structure."

Such innovative thinking is one reason DOE's Office of Science is launching its Center for Inverse Design Energy Frontier Research Center (EFRC) at NREL. Announced in April, the center has funding of $4 million annually for 5 years. It is one of 46 new EFRCs and includes research partners from Northwestern University, Oregon State University, and the Stanford University Linear Accelerator.

NREL Research Fellow Alex Zunger leads The Center for Inverse Design and describes its work this way: "This center will embark on daring research that uses quantum theory and high-performance computers to design new materials that have desired properties. Then it will use state-of-the-art synthesis to make those materials in the laboratory. Deliberate design of material with tailored properties is an inverse approach to traditional accidental discovery."

Zunger dubbed this approach "Quantum Jeopardy." Given the answer (e.g., a material having certain unique and useful properties), researchers must find the question (e.g., what material is it?). Larry Kazmerski, NREL's Executive Director of Science and Technology Partnerships and a member of the inverse design team said, "This new center is very exciting. It is a different way of doing science. We used to develop new materials—maybe with one property in mind—then measure them to see what they were good for. When we developed copper indium diselenide for thin-film PV, we first 'took what we got' and then spent 30 years refining it to get the rest of the properties we wanted. Now we can seek out all the properties that we want right from the start." The Center for Inverse Design will initially focus on producing PV materials, and the concept could eventually be applied to development of new materials for any purpose.

> **"The Center for Inverse Design and other six EFRCs give the laboratory the chance to do some really exciting work. These projects will be establishing whole new paradigms of energy science. They will also foster some great new relations with other research institutions and further establish our reputation for doing great science. "**
>
> **Ray Stults,**
> Associate Laboratory Director
> for Energy Sciences

In addition to leading the Center for Inverse Design, NREL researchers will participate in six other EFRCs with several U.S. universities and Los Alamos National Laboratory. ■

continued from page 4

resistance is nearly four times lower than the best performing commercial thermal greases and came very close to the research program target resistance (5 mm^2K/W) defined by NREL and industry. Narumanchi says these results are exciting. "This is a great opportunity to influence and optimize a new product. If this material passes further tests, a lot of people will be using it."

> **"This is a great opportunity to influence and optimize a new product. If this material passes further tests, a lot of people will be using it."**
>
> **Sreekant Narumanchi**

The Btech material also acts as an adhesive, which could be an important added advantage from a packaging perspective. NREL researchers are using scanning electron microscopes and other equipment to better understand and provide input into the development of this new material. ■

Knowledge, Knowledge Everywhere

Pat Corkery/PIX 15632

The considerable efforts of NREL's scientists, engineers, and analysts result in a wealth of knowledge and expertise … knowledge that tends to show up in a variety of places and expertise that gets requested by a variety of organizations. The brief stories on the next two pages highlight new publications, Web sites, and other activities in which the expertise and knowledge of NREL staff led the way or played a pivotal role.

Recent NREL Publications

Comparative Analysis of Three Proposed Federal Renewable Electricity Standards

With more than half the states having adopted renewable electricity standards or renewable portfolio standards (RPSs), the U.S. Congress is now considering several proposed national mandates for electric utilities to use renewable electrical generation. A May 2009 NREL report analyzes three leading proposals. The study calculates the resulting deployment of renewables under each of the proposals. It also projects the net impact on carbon dioxide emissions from that deployment, increased energy efficiency, and reduced power demand. Read the full report www.nrel.gov/docs/fy09osti/45877.pdf

Feed-In Tariff Policy: Design Implementation and Renewable Portfolio Standards Policy Interactions

Feed-in tariffs or FITs—essentially requiring utilities to purchase renewable electrical generation at set prices—are another way to foster renewable electrical generation. FITs have proven highly effective in Europe, and a number of U.S. states are considering them. They can apply to small distributed generation, such as a single PV system on a building, as well as utility-scale projects. They can complement or be used as alternatives to renewable electricity standards. A March 2009 NREL report examines FITs and their payment structure options. Read the full report www.nrel.gov/docs/fy09osti/45549.pdf

Photovoltaic Systems Interconnected onto Secondary Network Distribution Systems – Success Stories

In many urban or other concentrated load areas, electric utilities use secondary network systems with multiple feeders and transformers to provide greater reliability than with simple, more conventional radial networks. PV or other distributed generation systems can trip network protectors at the transformers in such systems unnecessarily, so utilities are reluctant to allow their connection. An April 2009 NREL report examines six case studies of successful PV connection to secondary network systems that employ four different means to avoid problems. Read the full report www.nrel.gov/docs/fy09osti/45061.pdf

SunPower/PIX 13339

This system on the roof of San Francisco's Moscone Convention Center is a successful example of a PV system connected to a secondary network system.

Assessment of the Energy Impacts of Outside Air in the Commercial Sector

Eighteen percent of U.S. energy consumption is by commercial buildings. Most commercial buildings employ mechanical ventilation with outside air to maintain air quality. An April 2009 NREL report found that such outside air use increases commercial building energy consumption by 6.6% on a national basis. The study calculated, however, that using advanced technologies could reduce that energy use increase to only 0.7%. The study also reported that unintended air leaks increase commercial building energy consumption by 27%. Read the full report www.nrel.gov/docs/fy09osti/41955.pdf ■

2008 Energy Data Book Now Available

NREL's Strategic Energy Analysis Office recently developed an updated new release of DOE's Office of Energy Efficiency and Renewable Energy's (EERE) 2008 Renewable Energy Data Book. The book contains valuable information on U.S. energy statistics, renewable electricity in the United States, global renewable energy (RE) development, clean energy investments, and data on specific RE technologies, all presented in a graphical format. It can be accessed at www.eere.energy.gov/maps_data/pdfs/eere_databook.pdf. ■

NREL Researcher Serves as Guest Editor for *IEEE Power & Energy Magazine*

Ben Kroposki, manager of NREL's Distributed Energy Systems Integration Group, was asked to be guest editor of *IEEE Power & Energy Magazine's* May/June 2009 issue that focuses on the large-scale integration of solar generating capacity into the grid. He assembled a group of expert co-authors to contribute six articles covering critical topics related to solar integration.

Kroposki, NREL's Robert Margolis, and DOE's Dan Ton discuss solar resource, solar energy basics, and two solar technologies—PV and CSP. Mark Mehos, NREL's CSP program manager, discusses the growing opportunities of CSP as a utility-scale generation option. Other contributors include authors from Japan and Germany and an Electric Power Research Institute and GE Energy in the United States. ■

Read the issue at www.ieee.org/organizations/pes/public/2009/may/index.html

Jim Yost/PIX 11162

Ben Kroposki in the Distributed Energy Reserves Test Facility

Henry Price/PIX 14940

SEGS plant in California described in the online CSP Projects database.

Online Database of CSP Power Plant Information

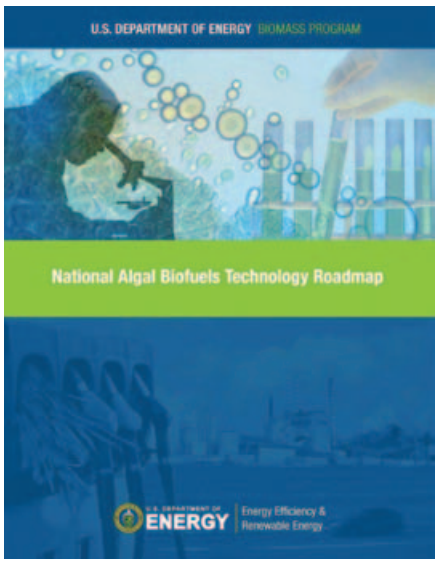
Every week brings news of CSP plants that are now operational, under construction, or in the planning stages. SolarPACES, an international group that focuses on advances in CSP technologies, asked NREL to create and maintain a CSP power plant database to help developers, financiers, and other groups get better access to data on the feasibility and success of such plants.

NREL's Mark Mehos works with various companies and his counterparts in other countries to collect the most relevant data. Users can search the more than 30 projects by country (currently Algeria, Italy, Morocco, Spain, and the United States), by technology (trough, linear Fresnel, power tower, dish/engine), by project name, or by status. The Web content will soon be available to all interested parties through the SolarPACES site (www.solarpaces.org) and can currently be viewed on the NREL CSP research site at www.nrel.gov/csp/solarpaces. ■

NREL Helps Set Course for Algal Biofuels R&D

Extracting fuel from algae—a possibility whose time may have come, again.

An NREL team of algae experts recently partnered with Sandia National Laboratories to help DOE complete a draft of the National Algal Biofuels Technology Roadmap. DOE will use the roadmap to direct R&D toward the goal of commercializing algal biofuels production, a process in which lipid oils are extracted from algae and processed into fuel. NREL did original research on algal biofuels as part of DOE's Aquatic Species Program (1978-1996) and is once again at the forefront as algae resurges as a feedstock candidate. DOE is currently incorporating comments from stakeholders. The final roadmap is scheduled for publication in the fall. ■



The National Algal Biofuels Technology Roadmap will guide R&D toward the goal of commercializing the production of biofuels from algae.

NREL Researchers Collaborate with Industry to Validate IEEE Standards

At least every five years IEEE standards need to be reaffirmed to remain technically up to date. Through facilitation by NREL researchers Peter McNutt and Ben Krosposki, IEEE 1526-2003 *Recommended Practice for Testing the Performance of Stand-Alone Photovoltaic Systems* was successfully affirmed recently. This standard provides procedures used by independent testing laboratories. The knowledge gained during the development of IEEE 1526 transfers to additional standards such as the IEEE 1547 series of standards and the newly initiated IEEE P2030 smart grid interoperability standards development activities. ■

M.A. Mortenson Company

The Integrated Biorefinery Research Facility will allow NREL to accommodate more collaboration requests from industry partners testing pilot-scale biochemical conversion.

Construction of New Biomass Research Facility Underway

NREL broke ground on a new facility for the next generation of biomass R&D in July. With that first shovel full of dirt, NREL is a step closer to launching the Integrated Biorefinery Research Facility (IBRF). The IBRF will allow researchers and industry partners to run a greater number and variety of pilot-scale biochemical conversion processes.

The IBRF is an expansion of the Alternative Fuels User Facility, NREL's existing research facility for developing ethanol or other fuels from cellulosic biomass. The new facility will include a high bay, pilot pretreatment and saccharification operations, and associated process equipment; modified lab space and new office space. The $33.5 million project is scheduled to complete Stage 1 (high bay) by summer 2010 and Stage 2 (office and labs) by summer 2011. ■

Greener Greens Lead to Whiter Whites

When it comes to light-emitting diodes (LEDs), you need greener green light to get to whiter white light. NREL researchers Angelo Mascarenhas, Lekhnath Bhusal, and Myles Steiner are using a radically different approach than other research groups to create an LED with a wavelength of 562 nanometers that produces a green light close to the peak of the spectral sensitivity of the human eye.

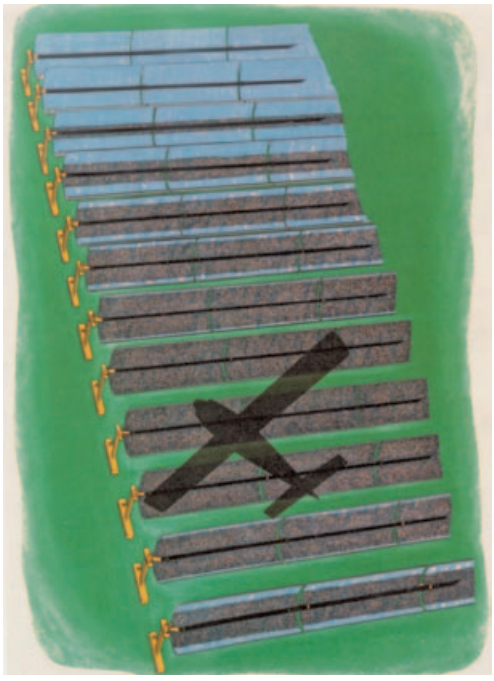
LEDs are much more energy efficient than incandescent and even compact fluorescent lights, but they come in colors. Getting an efficient white LED has been a major challenge. When this new green LED is combined with a red LED and blue LED, the resulting white light is substantially more efficient than existing sources.

The scientific basis of this sought-after green LED is a lattice-mismatched GaInP/GaAs tandem PV device (a focus of other NREL scientists). Mascarenhas and coworkers are tweaking the elemental composition of various layers and determining how to control the distortion of the atomic crystal lattice to create electronic properties that provide optimal colored-light emission. Ultimately, this innovative design could lead to a low-cost, manufacturing-friendly process for high-value energy-efficient LED lighting that generates much less heat than today's products. ■

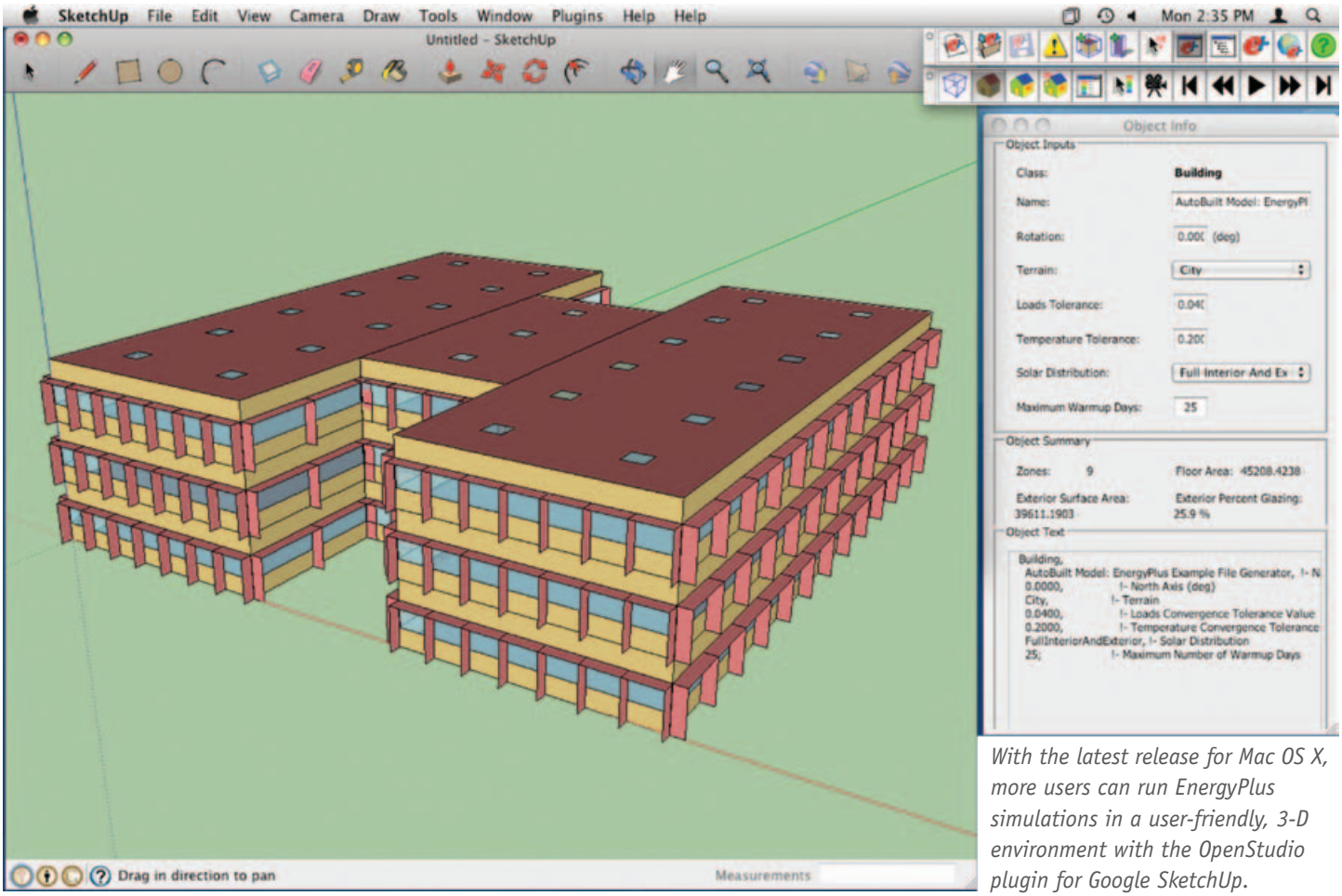
Experimental Tool to Analyze Solar Parabolic Trough Performance from a Distance

NREL's Thermal Systems Group is developing a new airborne photographic imaging capability to rapidly evaluate the performance of fields of parabolic trough concentrating solar collectors. Future fields are expected to increase in size to as large as 3 square miles. NREL estimates that inspections with its Distant Observer Tool (DOT) will be about 10 times faster than other inspection systems, and it will not interfere with normal operations—an added benefit. More than one dozen trough plants are proposed in the United States, so DOT will certainly benefit the CSP industry.

DOT uses a camera positioned over the collector field to analyze the images of the receiver tubes mirrored in the reflectors of the troughs. Parabolic trough collectors concentrate sunlight onto receiver tubes filled with a heat transfer fluid to drive a steam-turbine generator to produce utility-scale electricity. The optical quality and alignment of the collectors determine how effectively sunlight is concentrated on the receiver tubes. ■



NREL's Distant Observer Tool could significantly increase the speed of evaluating the performance of entire fields of parabolic trough concentrating solar collectors.



With the latest release for Mac OS X, more users can run EnergyPlus simulations in a user-friendly, 3-D environment with the OpenStudio plugin for Google SketchUp.

OpenStudio™ Software Continues to Build Fan Base with Architects

Not everyone thinks only in numbers. That's why NREL created OpenStudio, a plugin that makes it possible for architects and engineers to combine the building energy simulation capabilities of EnergyPlus to a user-friendly 3-D environment. EnergyPlus, DOE's popular building energy simulation software, models heating, cooling, lighting, ventilating, and other energy flows. OpenStudio is a free software plugin that adds functionality to the Google SketchUp™ drawing program. Because EnergyPlus lacks a graphical interface, OpenStudio makes it easy to create and edit building geometry using EnergyPlus input files.

Building energy simulation predicts the energy performance of a building's design before one board of the building is ever put in place, making it a powerful tool for architects and engineers. "OpenStudio software seamlessly integrates building energy simulation during the early design phases, enabling architects to evaluate energy-saving strategies when design changes are least costly," said Ron Judkoff, Program Manager, NREL buildings research. Unfortunately, simulation often occurs too late to effectively influence the building's architectural design.

Many architects give OpenStudio rave reviews. "This tool has revolutionized the future of building energy modeling, making highly accurate and comprehensive modeling and visualization of building energy flows much more straightforward by simply facilitating communication between SketchUp and EnergyPlus," said David Scheer, associate at Loisos + Ubbelohde Associates, Inc., a California firm specializing in high performance buildings. "Our firm uses OpenStudio everyday in energy modeling work for analysis of buildings from small residential to multimillion-square-foot commercial buildings, to inform design, calculate LEED credits, and communicate with our clients."

NREL researchers first proposed the concept of integrating building energy simulation software with SketchUp in 2007. The plugin, originally launched in 2008, was recently updated for Mac OS X in April 2009 and continues to gain in popularity. In addition to OpenStudio, nearly a dozen other software programs link building design to energy modeling software.

Learn more about OpenStudio at www.energyplus.gov/openstudio.cfm. ■

"Our firm uses OpenStudio everyday in energy modeling work for analysis of buildings from small residential to multimillion-square-foot commercial buildings … "

David Scheer,
Associate, Loisos + Ubbelohde Associates, Inc.

Xcel Energy and NREL Collaborating to Identify Reliable Delivery of Renewable Energy

Combine the largest provider of wind-generated electricity in the United States with premier renewable energy experts. Give them the challenge of identifying ways to reliably deliver renewable energy to utility customers, and a productive partnership is born.

The collaboration, called "Wind2H2" or the wind to hydrogen demonstration project, seeks to better understand how to improve delivery of renewable energy to customers at the right time and price. Wind turbines and PV panels generate electricity to produce hydrogen by electrolysis. The hydrogen is stored until it is needed to generate electricity for the grid. Knowledge gained from this ongoing demonstration, which began in March 2007, has already contributed to improving system designs, reducing costs, and developing methods for unattended operation so it is possible to make and store hydrogen more often.

"We worked with NREL," explained Xcel Energy's Frank Novachek, "because they had the technical know-how we needed."

In addition to its experienced researchers, Xcel Energy selected NREL because it had ideal resources at the NWTC near Boulder, Colorado. Facilities and equipment for the Wind2H2 project are located within the wide open spaces of this premier testing facility.

To learn more about Wind 2H2's specific research objectives and benefits, and to get more information about the project, including related publications, a video, and an animation, visit www.nrel.gov/hydrogen/proj_wind_hydrogen.html. ■

Pat Corkery/PIX 15756

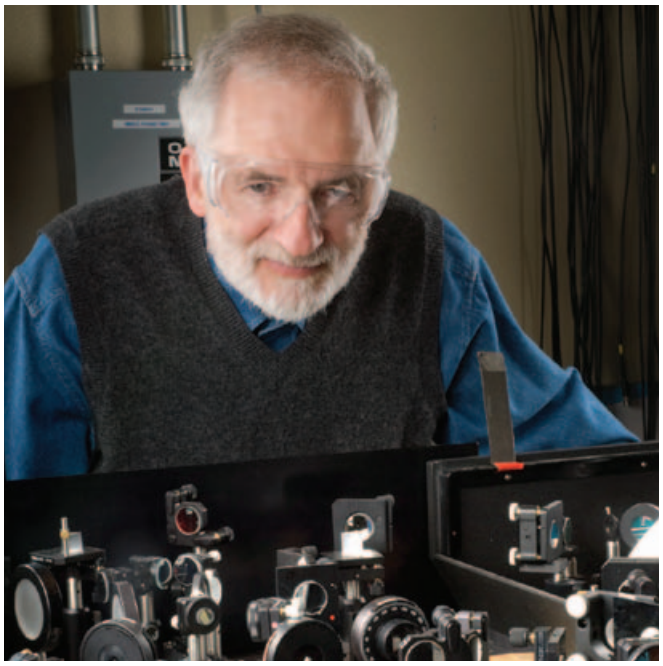
NREL Researcher Kevin Harrison inspects operations at the Wind2H2 project. This partnership project demonstrates producing hydrogen with energy from wind turbines or solar cells, then storing the hydrogen until needed to generate electricity.

UN Group Honors NREL Scientist

NREL Senior Research Fellow Arthur J. Nozik has won the 2009 Intergovernmental Renewable Energy Organization (IREO) Award for Science and Technology. IREO, a new organization related to the United Nations, works to promote the use of affordable sources of renewable energy worldwide. The IREO award recognizes those at the forefront of energy innovation and is the pre-eminent international award in the field of sustainable and renewable energy. Dr. Nozik and his NREL colleagues have proposed and confirmed several new—and potentially revolutionary—concepts in photoelectrochemistry and solar photoconversion. The ultimate goal of this work is to directly convert the sun's energy into electricity and fuels at a cost equivalent to, or lower than, the cost of coal.

2010 IEEE Steinmetz Award Goes to NREL Researcher

Dick DeBlasio, Laboratory Program Manager for Electricity Programs at NREL received the 2010 IEEE Charles Proteus Steinmetz Award. Dick was selected by the IEEE Board of Directors for his "contributions to the standardization and global impact of distributed electric power supply systems interconnection technology." The award is presented annually to an individual who has made exceptional contributions to the development or advancement (or both) of standards in electrical engineering. ■



Pat Corkery/PIX 15750

Recent IREO award winner Art Nozik and his team discovered and verified multiple-exciton generation in semiconductor nanocrystals, also called quantum dots.

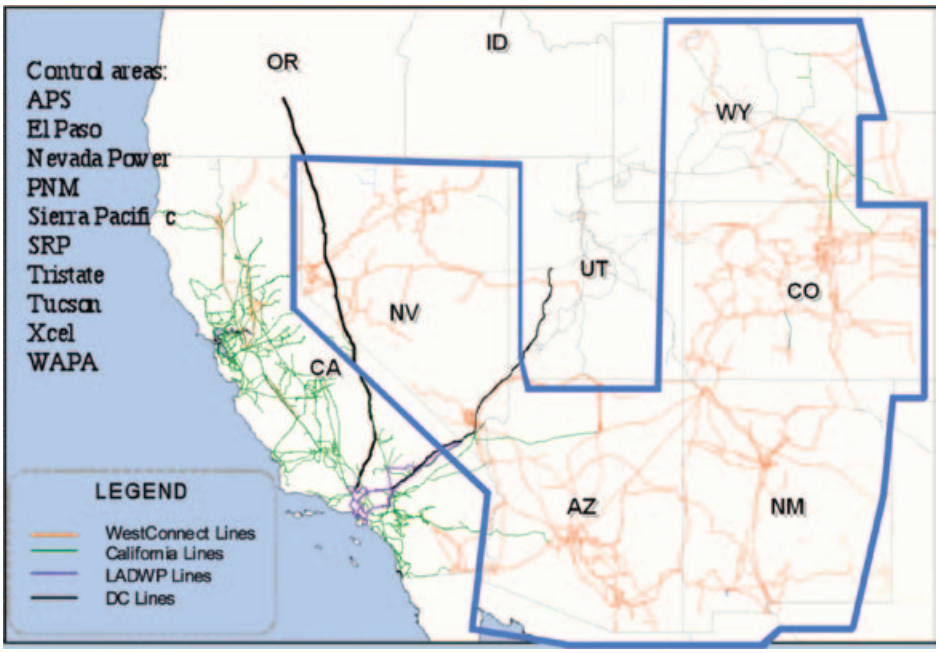
Getting to 20% Wind Energy by 2030 — NREL Undertakes Two of the Largest Integration Studies Ever Conducted

Wind energy could provide 20% of our nation's electricity needs by the year 2030, according to DOE. That's a far cry from the 25,000 megawatts of wind energy capacity that was in our nation's electricity portfolio at the end of 2008, which provides for about 2% of our nation's electricity demand. Simply put, to get to 20%, we have to install a lot more wind plants. And as the nation moves toward an energy market with greater use of wind energy, it is becoming more important for grid operators to understand how large penetrations of wind will affect the operation of the overall grid. NREL's Transmission and Grid Integration Group (TGIG) is lending its expertise to this challenge by supporting two of the largest wind-grid integration studies ever conducted—the Western Wind and Solar Integration Study (WWSIS) and the Eastern Wind Integration and Transmission Study (EWITS).

> "These studies are the first to look at the details of U.S. broad regional grids integrating up to 35% penetrations of wind and solar. The analyses are ground breaking, and critical to informing stakeholders and identifying research needs."
>
> **Brian Parsons**
> Manager, Transmission and Grid Integration Group

WWSIS is one of the world's largest regional integration studies to date. NREL is working with companies GE and 3TIER to investigate the impacts of integrating 20% and 30% wind and 5% solar into the grid in a large portion of the Western Interconnection by 2017.

The wind power production dataset developed in the study will be the basis for assessing the operating impacts and mitigation options due to the variability and uncertainty of wind power on the utility grids. This dataset was designed to help energy professionals perform wind integration studies, compare potential wind sites spatially and temporally, and estimate power production from hypothetical wind plants.

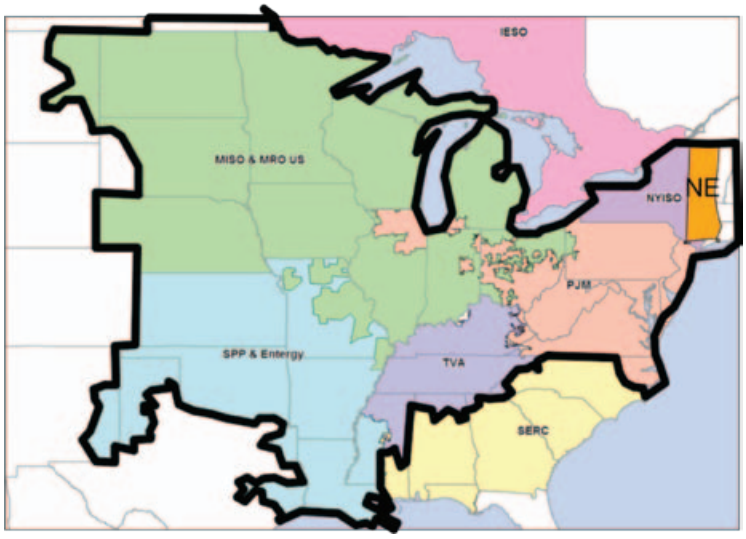


The WWSIS analyzes the operational impacts of wind and solar on generation in a large portion of the Western Interconnection.

EWITS encompasses most of the Eastern Interconnection, which spans the nation from the Midwest to the east coast. NREL is working with AWS Truewind, EnerNex, and the Midwest Independent System Operators (MISO) to produce a dataset similar to that produced for WWSIS and to analyze the grid operations and transmission scenarios that would be required to enable wind to produce 30% of the region's annual electricity demands.

According to Brian Parsons, NREL's TGIG leader, preliminary results from the two studies show that although 20% wind penetration will require aggressive transmission and generation expansion investments, 30% penetration would likely require a rethink on operational practices and wide use of non-conventional mitigation measures for wind's variability and uncertainty.

The results from both studies, which will be completed in early 2010, will be publicly available online at www.nrel.gov/wind/systemsintegration/ ■



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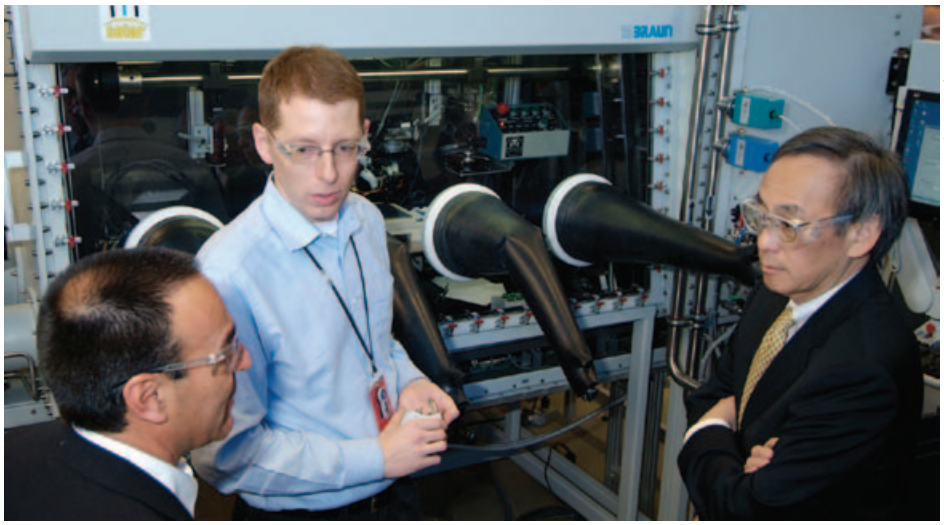

Jim Yost/PIX 16285

Secretary of Energy Steven Chu (right) listens to NREL Senior Scientists Miguel Contreras (left) and Maikel van Hest as they demonstrate new ink-jet printing technology for thin-film PV.

New DOE Top Brass Checking Out NREL

If visits by high-level officials are any indication, NREL's capabilities and programs are near the top of the list for new DOE appointees. Secretary of Energy Steven Chu visited NREL in April. Deputy Secretary of Energy Daniel Poneman spent two days here in May. And Under Secretary for Energy Kristina Johnson and Assistant Secretary for Energy Efficiency and Renewable Energy Cathy Zoi visited in June.

The Secretary announced $110 million in capital improvements funding for NREL. He also toured NREL facilities and heard briefings on cutting-edge research from research staff and NREL partners alike. Most of the Secretary's (and other visitors') time was spent in the Process Development Integration Laboratory, NREL's unique collaborative facility where industry works directly with researchers to rapidly turn solar PV innovations into commercial products. ■

NREL Welcomes New Wind Center Director

Dr. Fort Felker became center director for NREL's NWTC in May. Felker has 30 years of experience in leading engineering R&D. Most recently, Felker was the co-founder and vice president of Winglet Technology LLC. Prior to that he served as an engineering analyst at Lawrence Livermore National Laboratory and in senior engineering positions at Kenetech Windpower, where he developed wind turbine engineering analysis tools, played a key role in the development of the KVS-45 wind turbine, and led a team of engineers and technicians in the testing of large wind turbine systems. He has also worked with the NASA Ames Research Center and the U.S. Army Research and Technology Labs. ■

Lee Fingersh/PIX16295

New Director for National Center for Photovoltaics

Dr. Ryne P. Raffaelle became NREL's new Center Director for the National Center for Photovoltaics (NCPV) in August. Rafaelle comes to NREL with nearly 20 years of experience and leadership in science R&D teams in university laboratories and with photovoltaics or high-technology industry start-up companies. Recently, he served as Academic Director for the Golisano Institute for Sustainability, Director of the NanoPower Research Laboratory, and as professor of Physics, Microsystems Engineering, and Sustainability at Rochester Institute of Technology (RIT). While at RIT he lead or co-lead more than $20 million in research grants in PV, thin-film processing, and nanomaterials research. He has also worked at NASA-Glenn Research Center, the Florida Institute of Technology, and Oak Ridge National Laboratory. He is co-founder of Wakonda Technologies, Inc. and Alpha V, Inc. ■

Energy Innovations is a publication of the National Renewable Energy Laboratory.

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NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

NREL/BR-6A4-45950 • September 2009

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% post consumer waste.

Editor's Note: In the "NREL Develops New Reference Solar Spectrum" article (Energy Innovations Spring 2009, pg. 3), we neglected to mention the important contributions of Dr. Christian Gueymard. Through an NREL subcontract, Dr. Gueymard revised his spectral model, developed at the Florida Solar Energy Center, to create the American for Society for Testing and Materials (ASTM) and International Electrotechnical Comission (IEC) revised reference solar spectrum for photovoltaic standard test conditions. ■