Save with Solar & Wind

Summer 2002

A technical bulletin for Federal solar and wind energy champions

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U.S. Department of Energy
Federal Energy Management Program

A New Approach to Achieving the Federal Goal for Renewable Energy

By Anne Sprunt Crawley, DOE Federal Energy Management Program; Nancy Carlisle, AIA, National Renewable Energy Laboratory; and Kevin DeGroat, McNeil Technologies

Federal agencies have a defined goal for the amount of renewable energy they need to be using by 2005: the equivalent of 2.5% of total Federal electricity consumed, as detailed in Executive Order (E.O.) 13123 and its implementing guidance. The E.O. defines renewable energy as solar, wind, biomass, and geothermal energy systems.

The Bush Administration's National Energy Policy report supports developing the nation's renewable resources: "We can ensure that America will lead the world in the development of clean, natural, renewable and alternative energy supplies … These non-depletable sources of energy are domestically abundant and often have less impact on the environment than conventional sources. They can provide a reliable source of energy at a stable price."

David Garman, Assistant Secretary for Energy Efficiency and Renewable Energy at DOE, has defined eight priorities; two of them support Federal renewable energy use. One priority is to increase the viability and deployment of renewable energy; the other is to lead by example through the government's own actions.

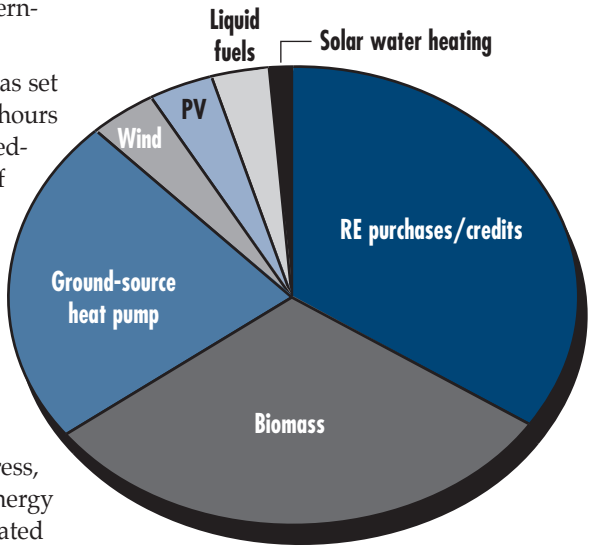
When the renewable energy goal was set in June 2000, it equaled 1,355 gigawatt-hours (GWh) of electricity. At that time, the Federal government was using 173 GWh of new renewable energy, or about 13% of the goal. Data available in May 2002 indicate that the government now consumes about 309.3 GWh of new renewable energy. However, Federal electricity use has also increased, so current renewable energy use is only about 14% of the revised goal of 1,422 GWh. To accelerate progress, the Department of Energy's Federal Energy Management Program (FEMP) has created a novel approach with three elements, as described on p. 2. This approach involves implementing more traditional projects, green power purchases, and facilitated projects in which renewable energy is developed on Federal lands.

The chart on this page shows the technologies currently used. The key contributor is

(Continued on p. 2)

Current Federal Use of Renewable Energy Technologies

Technology	GWh
Solar water heating	4.7
Biomass	92.8
Wind	11.6
Renewable energy purchases/credits	106.8
Photovoltaics	11.1
Ground-source heat pump	71.9
Liquid fuels	10.4
Total generation estimate	309.3



Achieving the Federal Goal (from p. 1)

biomass power, which is somewhat surprising. The size of this contribution is influenced by a large wood waste power plant at Fort Stewart, Georgia, as well the Navy's purchases of steam from a refuse-derived-fuel plant in Portsmouth, New Hampshire.

Ground-source heat pumps (GSHPs) also make a significant contribution. This is primarily the result of the Army's use of 4,003 GSHPs at Fort Polk, Georgia. Only the amount of energy exceeding the amount used by a conventional heat pump can be counted as renewable energy from GSHPs, however.

In terms of the number of installations, photovoltaics (PV) is also leading contributor. Thousands of PV systems are in use in the Federal sector, ranging in size from a few watts to 350 kW. But most are very small.

FEMP is committed to helping agencies use all the kinds of renewable energy listed in the Executive Order, and to reach the goal in the most practical way for the lowest cost consistent with the goal. This commitment also includes building a sound business foundation for expanding the Federal government's use of renewable energy in the long term.

In addition to providing information about renewable energy and recognizing successful activities, FEMP is pursuing three approaches to meeting the goal. The approaches include—

- Increasing the amount of renewable energy that Federal on-site projects generate, by promoting either larger projects—such as wind, biomass, or geothermal—or multiple applications of individual technologies—such as solar hot water, PV, or GSHPs.
- Increasing purchases of renewable power or renewable energy credits (RECs); RECs involve a financial transaction that supports investment in renewable energy projects without the complications associated with the physical delivery of power to a site.
- Encouraging agencies to facilitate renewable energy projects that use Federal lands and resources or that serve the direct customers of agencies—for example, large-scale development of a wind farm on a Federal site where the power is sold to the site, to a utility, or both.

On-site projects. To date, most Federal efforts have supported the first approach—projects at Federal sites. To meet the Federal goal, these projects are expected to provide up to 15% of the renewable energy goal, or 213 GWh, according to a recent study done for DOE FEMP. Currently, projects provide 62% of installed renewable energy generation in the Federal sector. Even though projects will probably contribute only a small fraction to the goal, they are very important; they allow agencies to gain first-hand experience with a technology, and they offer a way to showcase technologies to other agencies and to the public.

FEMP is also interested in developing new ways to promote multiple applications of individual technologies. These include large-scale applications of solar water heating, and large projects involving biomass and geothermal energy. And FEMP wants to improve and simplify the way that passive solar measures could be estimated and counted toward the goal. To date, passive solar measures have not been counted; therefore, their contribution is not reflected in the Federal data base.

Renewable power purchases. Renewable power purchases, including RECs, make up approximately 38% of current Federal renewable energy use, or 106.8 GWh. Renewable power purchases and RECs could meet at least 15% of the goal, or 213 GWh. FEMP is currently assisting agencies with both of these options.

Publications like *Purchasing Renewable Energy: A Guidebook for Federal Agencies* (*http://eetd.lbl.gov/ea/ems/reports/46766.pdf*), prepared by Lawrence Berkeley National Laboratory, can be helpful. And a Renewable Power Purchasing Toolkit prepared by the DOE Denver Regional Office and the National Renewable Energy Laboratory (NREL) has been sent to DOE and General Services Administration (GSA) Regional Offices. For additional information, please see *www.gsa.gov/pbs/centers/energy/green.htm*.

Facilitated projects. Currently, only 2 GWh of facilitated Federal renewable energy projects are in place that count toward the goal. However, 740 GWh of such projects are being either considered or planned. Because facilitated projects are not constrained by Federal demand and are usually much larger than on-site projects, they could provide up to 70% of the renewable energy goal by 2005.

Facilitated projects represent a departure from FEMP's traditional focus on technical and financial information and assistance for on-site projects. So, FEMP's role in encouraging and assisting these projects will develop over time. FEMP supports a broad DOE/Department of the Interior initiative under the National Energy Plan to encourage renewable projects on Federal lands. However, much of the demand for facilitated projects is driven by the private sector's interest in using renewable resources on these lands.

To show true progress in meeting the goal, we encourage all agencies to share their successful projects with FEMP through our tracking database. This should be available soon on the FEMP Renewable Energy Web site (*www.eren.doe.gov/ femp/techassist/ renewenergy.html*).

For more information, please contact Nancy Carlisle, NREL, 303-384-7509, or Anne Sprunt Crawley, DOE FEMP, 202-586-1505. ■

Renewable Energy Systems and Energy Efficiency Contribute to Homeland Security

By John Thornton, National Renewable Energy Laboratory

The U.S. Department of Energy (DOE) was designated the lead Federal agency for protecting the nation's energy infrastructure in Presidential Decision Directive 63, signed on May 22, 1998. Suddenly, DOE had the somewhat daunting responsibility of protecting more than 157,000 miles of electrical transmission lines, 5,000 power plants, 3.3 million miles of oil and gas pipelines, 150 oil refineries, and 2,000 petroleum terminals.

Safety concerns intensified in the aftermath of September 11, 2001, as the newly created White House Office of Homeland Security realized how vulnerable the domestic energy infrastructure is to terrorist attack. Protecting our energy infrastructure rapidly became—and still remains—a high priority within DOE. Because the majority of that infrastructure is owned by the private sector, DOE's effort has to be collaborative.

Soon after September 11, Deputy Secretary of Energy Francis S. Blake convened a special task force consisting of one member from each of the national laboratories to (1) identify technologies and capabilities currently within the laboratory system that could enhance the protection efforts of both DOE and private sector, (2) develop a process for defining and prioritizing an R&D plan, and (3) recommend a strategy for coordinating these efforts within the laboratory system. The task force, which was convened on December 7, 2001, provided recommendations to Deputy Secretary Blake in a briefing on February 14, 2002.

The task force concentrated on identifying immediate to short-term vulnerabilities and developing appropriate protection strategies that DOE can apply within the next 6 to 12 months. In the coming months, the task force will shift its focus to long-range strategies.

Clearly, energy efficiency and renewable energy technologies have enormous potential—particularly in the mid- to long term—to contribute to homeland security and to reduce our vulnerability to terrorist attacks and natural disasters. Distributed energy systems and alternative fuels were just two of the many technology areas the task force identified as having great potential to reduce vulnerabilities.

What is often not realized is that energy efficiency and renewable energy systems can make significant contributions in the immediate to mid-term, as well. Commercially available wind turbines and photovoltaics (with battery storage) can both meet the tough "6-9s" reliability demanded by monitoring, control, intrusion detection, and communication devices that can detect hostile attacks and protect our energy infrastructure.

John Masson/PIX11040

Photovoltaics provides high-reliability power for a communications tower in Dinosaur National Monument.

Since the early 1990s, mobile PV systems have repeatedly demonstrated their emergency response capabilities, as in the aftermath of Hurricanes Andrew, Hugo, and Marilyn and the Northridge, California, earthquake. Applications range from generating power for shelters and camps, medical clinics, communication centers, and gas stations to providing backup power for utility recovery operations. The Federal Energy Management Program (FEMP) has provided eight mobile PV units, now housed in Maryland, to the Federal Emergency Management Agency (FEMA) in 1998 for further testing and evaluation.

In addition, energy-efficient buildings used as command-and-control centers are less dependent than others on grid power and need less backup power to sustain operations if the grid fails. Evidence collected during hurricanes and ice storms indicates that the more robust construction associated with energy-efficient buildings substantially increases their ability to survive natural disasters.

Working with FEMP, Federal agencies have set powerful examples of energy security for state and local governments as well as for the private sector. The importance of Federal agencies as role models will become even greater as homeland security efforts intensify.

For more information about homeland security applications, contact John Thornton, NREL: John_Thornton@nrel.gov. ■

Power Surges!

"Power Surges" are off-the-cuff fun facts about renewable energy in the Federal sector. The accuracy of these claims is likely but not guaranteed, because it is largely based on who speaks the loudest during the debate.

Ambassadors of Solar: The U.S. Department of State uses renewable solar energy at embassy and consulate facilities for domestic water preheating and swimming pool heating; more than 350 systems and 1200 collectors are in place worldwide.
From David Hauk, OBO/OM/FAC/PS

Most Solar Hot Water Systems on a Marine Base: Seventeen solar hot water systems installed at Camp Wilson at MCB 29 Palms provide essentially all the hot water used at the camp for about three-quarters of the year. They are also the most systems installed on a Marine base at one time (see announcement on p.2).
From David Menicucci, Sandia National Laboratories

Most Solar Hot Water Systems in the Federal Government: COMNAVREG HAWAII, Navy Aloha Center, installed 1,898 solar water heating systems, bringing the total to 2,352 systems in Oahu Navy Family Housing. *From Alan I. Ikeda, PACNAVFACENGCOM 081*
(Note: In a random poll of Federal energy managers, Moanalua Terrace in Hawaii was rated as one of the most desirable MSR sites to visit.
From Kevin DeGroat, McNeil Technologies)

Northernmost Renewable Energy Systems: The Federal Aviation Administration (FAA) has at least 40 remote PV sites at radio communication links and remote center air/ground communications facilities, primarily in the western United States. The FAA's Chandalar Lake Non-Directional Beacon, near the Arctic Circle, is powered by two 7.5-kW wind turbines and a 5.1-kW PV array. The wind turbines generate as much as 150 amps in gusty wind conditions, reducing demand for fossil fuel.
From Brenda Howard, FAA

Southernmost Renewable Energy Systems: Alternative energy (wind and solar) is used extensively in Antarctica, for environmental and practical reasons. Raytheon Polar Services' systems range from a single 30-W panel and 100 amp/hour battery to those that produce 1200 W continuously, coupled to a 2000 amp/hour battery bank. The most remote ones are several hundred miles from McMurdo Station and at the South Pole.
From Andy Young, Raytheon Polar Services

Most Renewable Energy Systems in the Federal Government: The Department of Defense has the most, as well as the most diverse; DoD's thousands of systems include PV, solar hot water, geothermal heat pumps, wind systems, and transpired collectors. At more than 145 GWh per year, DoD uses the most renewable energy in the Federal government.
From Kevin DeGroat, McNeil Technologies

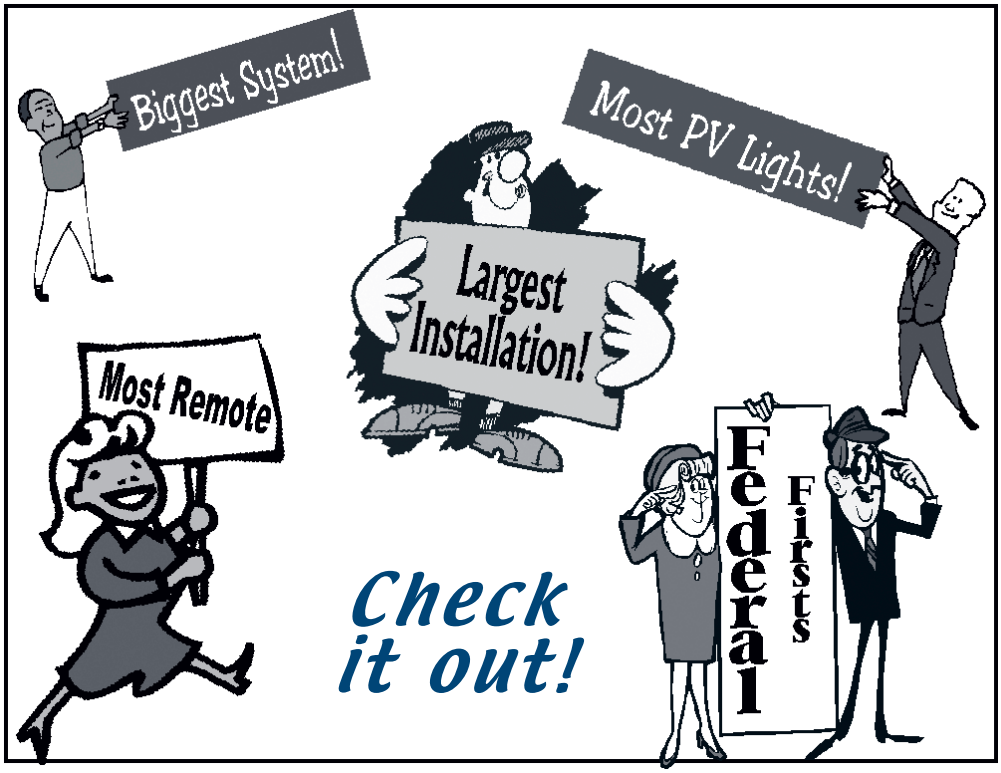
Highest Renewable Energy System in the Federal Government: The solar panels on NASA's Solar and Heliospheric Observatory (SOHO) satellite, approximately 1 million miles from Earth at the L1 orbit point between the Earth and the Sun; soon to be joined by the Triana satellite, designed to study how Earth's climate works as an integrated system.
From Kevin DeGroat, McNeil Technologies

Largest Remote Photovoltaic/Diesel/Battery Hybrid System: The PV/diesel/battery hybrid power system at the Superior Valley Tactical Training Range, Naval Air Warfare Center Weapons Division, China Lake, California, may be the largest remote hybrid system of its kind in the world, with a 350-kWp array, a 300-kW diesel generator, and 3500-kWh lead-acid batteries.
From Chuck Combs, Tri-Service Renewable Energy Committee

Largest Renewable Power Plant: The Navy hosts the largest renewable power-generating station in the Federal sector: the 220-MW Coso Geothermal Power Plant at NAWS, China Lake, California.
From Kevin DeGroat, McNeil Technologies

Largest Renewable Power Contract: The Air Force has the largest, at 33 million kWh, ramping up to 133 million kWh (100% of the load) in three years.
From Chandra Shah, NREL

Most Renewable Power Contracts: EPA has the most of any agency (five), although GSA has helped put the most renewable power deals in place for client agencies.
From Chandra Shah, NREL



First Thermal Tile Air-Heating System: The U.S. Geological Survey installed the first thermal tile air-heating system at its Reston, Virginia, Headquarters; USGS also installed the first-of-its-kind solar thermal heating system for emergency diesel generators (see article on p. 6).
From John Archibald, American Solar

First Completely Green-Powered Building: In 1999, EPA had the first building powered completely by renewable power, at facilities in Richmond, California.
From Kevin DeGroat, McNeil Technologies

Largest Installation of Geothermal Heat Pumps: Fort Polk, Louisiana, has the largest installation of geothermal heat pumps in the world: 4,000 units that save the base $3.3 million in energy costs annually.
From Kevin DeGroat, McNeil Technologies

Biggest Ground-Based Photovoltaic System: Yuma Proving Ground has the biggest in the Federal government, at 450 kW. It's grid-connected and includes battery storage and sophisticated controls, so it "shaves" peak loads and can operate the water system in case of an emergency.
From Kevin DeGroat, McNeil Technologies

Largest Thin-Film Photovoltaic Installation: GSA has the largest: a 100-kW array at its Suitland, Maryland, facility.
From Kevin DeGroat, McNeil Technologies

Largest Federal Photovoltaic Installation Using AC Modules: The Pentagon has the largest one: 30 kW in front of the Pentagon's heating and cooling plant. Rather than connecting to one inverter, each PV panel has a miniature inverter to convert from DC to AC power.
From Kevin DeGroat, McNeil Technologies

Most Photovoltaic-Powered Lights: The U.S. Army has installed the most PV-powered parking lot lights in one facility at Fort Hood, Texas; more than 170 solar-powered street-light systems are on the base.
From Save with Solar, Vol. 2, No. 2, Fall 1999

Longest PV-Lighted Federal Road: The U.S. Environmental Protection Agency has the longest stretch of Federal roadway—more than a mile—illuminated by solar-powered lights at its new campus in Research Triangle Park, North Carolina. *From Chris Long, EPA*

First Outdoor Solar Classroom: The Bureau of Indian Affairs in the Department of the Interior constructed it; Seba Dalkai Boarding School in Arizona uses a photovoltaic pavilion as a classroom and an uninterruptible power supply for the school's computers.
From Save with Solar, *Vol. 3, No. 1, Spring 2000*

Largest Building-Integrated Photovoltaic System in a Civilian Agency: The largest Federal BIPV system (127-kW nameplate rating) resides at the U.S. Postal Service's Marina Processing and Distribution Center in California (see p. 7).
From Bill Golove, Lawrence Berkeley National Laboratory

Hottest Photovoltaic System: The most coveted renewable energy system in the Federal government has been at Joshua Tree National Park in California, operated by the National Park Service. How do we know? Just last year, somebody liked it so much they stole it.
From Kevin DeGroat, McNeil Technologies

Largest Federal Wind Power Installation: The largest Federal wind power installation is on Ascension Island in the South Atlantic, where the U.S. Air Force Space Command has installed four 225-kW turbines and has plans for six more.
From Kevin DeGroat, McNeil Technologies

First Wind Turbine Installed at a National Wildlife Refuge: This is the Bergey Excel-S 10-kW Wind Generator at Eastern Neck National Wildlife Refuge in Rock Hall, Maryland.
From Richard E. Deutschmann, Chesapeake Wind & Solar LLC

Best-Ever Renewable Energy Stories: These come from Steve Butterworth of the National Park Service.
From Kevin DeGroat, McNeil Technologies

Wind Energy Update: Nevada Test Site

By Ed Cannon, National Renewable Energy Laboratory

Nevada Power Company has announced a power purchase agreement for 100% of the electricity produced by an 85-megawatt (MW) wind farm at the Nevada Test Site northwest of Las Vegas. The project includes 57 wind turbines that could produce enough clean energy to serve a community of about 50,000 people. Construction is expected to begin this summer, so the power plant could begin operating by December 2003.

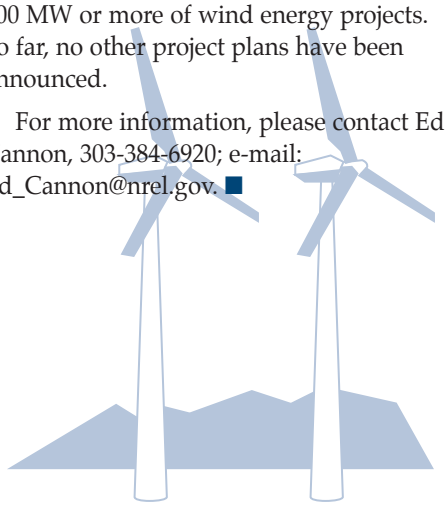
Under a new Nevada renewable portfolio standard, Nevada Power must obtain 5% of its total energy from renewable sources by 2003, increasing gradually to 15% by 2015. The utility will purchase all the power generated at the Shoshone Wind Farm in the Nye County portion of the test site for 17 years, with an option to extend the contract for eight more years. Nevada Power representatives did not disclose the price, but they indicated it is a favorable one.

MNS Wind, the power plant developer, is a 50/50 joint venture between Global Renewable Energy Partners, a wholly owned subsidiary of NEG Micon A/S and one of the world's largest wind turbine manufacturers, and Siemens Energy and Automation, the project's construction partner.

John Johansen, president of MNS Wind, is quoted in the Las Vegas *Review Journal* as saying the agreement represents "an effective working partnership" between private businesses and the Department of Energy, which oversees the test site.

The Nevada Test Site encompasses about 1,350 square miles of desert and mountainous terrain, and it could eventually support 600 MW or more of wind energy projects. So far, no other project plans have been announced.

For more information, please contact Ed Cannon, 303-384-6920; e-mail: Ed_Cannon@nrel.gov. ■



Eco-Building Stands Alone at Papago Park Military Reservation

By Jeff Seaton, CEM, Arizona Army National Guard

The Arizona Army National Guard is constructing a fully functional, self-sustaining new office building at Papago Park Military Reservation in Phoenix. The building reflects the Guard's commitment to conservation, pollution prevention, energy-use reduction, and energy efficiency.

Appropriately named the "Eco-Building," the new 5,200-square-foot structure incorporates numerous environmentally sustainable and pollution-prevention principles. For example, the primary building materials are "bricks" made of used tires and earth. Earth is compacted inside intact tires to create a round adobe brick encased in rubber. These bricks are used to construct the walls, and earth berming is used on the exterior to provide structural support and thermal mass.

Additional environmental features include an 11-kilowatt solar array, with solar trackers, for renewable electricity production; a roof design that harvests rainwater and contains water storage cisterns; a closed-loop wastewater treatment system; cooling tubes that use geothermal energy for cooling; a radiant barrier under the roof to mitigate heat transfer; active and passive daylighting systems; and many other energy-efficient materials and products.

State of Arizona-DEMA/PIX11063

Sun-tracking solar systems on the roof help to make the Arizona National Guard's Eco-Building self-sustaining.

The building operates independently; it is not hooked up to conventional utilities such as electricity, sewer, and municipal or well water. Systems that meet these needs using alternative technologies are built into the structure.

The Eco-Building is unique not just for the construction materials and methods used and the types of systems integrated into one structure, but also for using inmates from the Maricopa County's Sheriff's Office for the labor, to reduce construction costs. The building and its project team have been recognized with several Federal and state awards.

For more information, and to view Webcam images of the Eco-Building, visit its Web site at *www.azecobuilding.com*. ■

Solar Heating System Keeps Generators Ready To Run

By John Archibald, American Solar, Inc.

Facility managers can use solar energy in dozens of ways to save money, increase reliability, and cut construction costs. Solar energy systems can generate electricity, heat air and water, and drive high-temperature processes in hundreds of different applications in every climate zone.

New solar applications are constantly being developed. One new solar heating technology saves energy needed for an almost-forgotten energy consumer, the emergency diesel generator (EDG). This new solar technology saves both energy and money while keeping EDGs ready to run in an emergency.

American Solar, Inc./PIX11064

A solar tile system keeps emergency generators warm.

Facility managers know EDGs can be the last line of defense in supplying electric power. They count on the EDG's quick response to supply emergency power for lighting; heating, ventilation, and air-conditioning equipment; computers; security; pumping applications; and health care systems. However, most EDGs are in ventilated enclosures where cold air surrounds the engine. Because EDGs sit idle for days or weeks at a time, facility managers may worry that the cold diesel engines will not start when needed.

To ensure that they will start reliably, EDGs are often warmed with electric resistance heaters. These electric heaters can use up to 10 kilowatts (kW) of power when heating a cold 1000-kW generator. And, even on days when outside temperatures are in the seventies, a mid-sized generator pulls more than 2 kW to keep the engine water at 130ºF. In fact, an emergency diesel generator uses about 10 times more electricity per square foot than a typical office building does.

To increase efficiency as well as reliability, American Solar, Inc., has introduced a new solar heating system specifically designed to heat EDGs so they will be ready to start. The solar tile system uses sunlight and a small fan to heat air in the generator enclosure up to 110ºF. The solar tile system delivers several thousand watts of thermal energy to the air using only a few hundred watts of power for the fan. Solar-heated air surrounds the diesel engine, keeping it warm by reducing heat loss to the outside air.

The warm air near the engine air intake also speeds the initial combustion of fuel in the cylinders. Electric heaters are retained to provide peak heating up to 130º F, but they operate at lower power, saving enough electricity to pay for the solar system.

"Our emergency generators used large electric heaters to stay warm and ready to run. Using solar heat helps warm the generators and meet the Executive Order goal of expanding our use of renewable energy," said Bob Sapp, Chief of Operations and Maintenance, U.S. Geological Survey, Reston, Virginia.

For more information, please contact John Archibald, 703-346-6053; e-mail: jarchibald@americansolar.com; Web site: *www.americansolar.com*. ■

USPS Links PV, EMS in "Smart" New Solar System

By Bill Golove, Lawrence Berkeley National Laboratory

The United States Postal Service (USPS) has installed a new, cutting-edge, renewable energy system at its Marina Processing and Distribution Center in Los Angeles. The system links a solar photovoltaic (PV) array with an energy management system (EMS) in a demonstration project highlighting these technologies. The 409,000-square-foot Marina Center facility was chosen for this project in part because of the large expanse of roof space available for the PV system. Even more important was the interest and commitment of senior plant management.

Staff at Lawrence Berkeley National Laboratory (LBNL) provided a key technical advisory role in the project. They have found in working with Federal agencies that having a project champion who sees it through to completion is a key success factor. For the Marina Center, champions emerged from both agency management and the facility itself.

Ray Levinson, USPS Area Energy Manager, was one of them. He said, "The site's proactive management team was an essential consideration in selecting the project location."

This project should save $25,000 to $28,000 per year in energy-related costs and pay for itself in 8 or 9 years. The USPS will save an estimated total of $880,000 in energy costs over the guaranteed lifetime of the system. The project was also designed to respond to the state's call for voluntary demand reductions, demonstrate the viability of PV for the USPS, and test the value of linking PV and an EMS.

The project features a 127-kilowatt PV rooftop installation. PowerLight Corporation's PV technology was chosen largely because roof penetration was not required for installation. The added insulation value provided by this product, as well as possible extension of the roof's life, were also important considerations.

The PV system is linked to a new CMS Viron EMS, which measures power output from the solar cells. When the EMS detects a decline in output—for instance, because of a cloud overhead—it automatically slows down the building's chiller in response to reduced solar radiation. This allows the total system to maintain a consistent reduction in demand from the utility grid, and it helps avoid high charges resulting from surges in demand.

The opportunity to link the PV system to the EMS was in part fortuitous. While the PV system was being installed, USPS was also obtaining demand-response technology under a grant from the California Energy Commission. At the same time, the Los Angeles Department of Water and Power, the utility serving the facility, increased the already sizeable rebate available to the project by $100,000. So, incentive programs also played a major role in making the project possible. A grant from the Distributed Energy Resources Program in the Department of Energy's Federal Energy Management Program further reduced the cost of the PV system to USPS.

In addition, PowerLight and CMS Viron had been looking for an opportunity to test this linked system concept. With the additional funds and the potential for substantially increased savings, the project became a win-win-win opportunity for all three major partners.

USPS hopes to determine the potential for future installations, so PowerLight will monitor the system for two years. Dan Shugar, President of PowerLight, said, "This installation showcases the U.S. Postal Service's energy and environmental leadership. Based on the success of this project, we hope to see a series of cost-effective PV installations at USPS facilities across California and the rest of the country."

George Marsh/PIX11017

Project partners (left to right) Joe VandenBerg and Ray Levinson of the U.S. Postal Service and Dan Shugar of PowerLight Corp. worked with representatives of the local utility and others to install this 127-kW PV system on the rooftop of the USPS Marina Center in California.

An LBNL project member also noted that the USPS has long demonstrated leadership in moving toward an economically sound, sustainable energy future, and that Ray Levinson in particular should be commended for his efforts.

For more information, please contact Bill Golove, LBNL; e-mail: WHGolove@lbl.gov. ■

Solar Power, Thanks to "Plug-n-Play"

By Jeffrey Dewey, Acquest Development

The Environmental Protection Agency (EPA) New England is leading by example. At EPA's Region 1 Laboratory and Office of Environmental Measurement & Evaluation in North Chelmsford, Massachusetts, the agency monitors environmental actions in the six New England states. Besides its monitoring function, EPA's lab complex also demonstrates the benefits of energy efficiency and renewable energy. The facility "walks the talk" by incorporating an array of environmental features. These include energy-efficient heating and cooling systems, enhanced daylighting, recycled materials, environmentally friendly landscaping, aggressive indoor air quality measures, and support for wind-powered electricity.

The facility also employs a new building-integrated photovoltaic (BIPV) product known as the PowerShade™. This product is a sun shade that converts sunlight to electricity. The PowerShade not only saves money by reducing heating and cooling costs in the traditional manner of window shades, it also harvests the sun's rays for electricity production. Although numerous PV sunshades are available in Europe, they are custom-designed for specific buildings.

(Continued on p. 8)

Solar Power (from p. 7)

In contrast, the PowerShade was designed by Kawneer Company to be a single, easily configured product adaptable to a range of buildings. It can even be installed by contractors who have expertise in window and storefront installations but not necessarily in high-tech product installations.

The PowerShade was not on the market during the preliminary building design. So Acquest, the building's developer, was able to obtain the product only after construction had already begun. However, the design-build process selected was flexible enough to accommodate a major new building element. The product's unique "plug-in" feature allowed the supporting windows to be installed on schedule and the shade, with its long lead time, to be attached at the end of construction.

The PowerShade model 1600 array consists of three identical louver blades, each incorporating a standardized BP Solar 20-watt PV module. These blades are mounted on a unique strut assembly with two strategically positioned pivot points. A non-articulated pivot point joins the two components of the strut assembly, enabling a wide range of extension. A second, non-articulated pivot point is at the connection of the louver blade so it can be optimally positioned for a large solar harvest. The struts are readily bolted to a standard curtain wall frame prepped with simple blocking and locater pins.

J.A. Dewey/PIX11065

The PowerShade™ technology shades windows and generates electricity at EPA's lab complex in North Chelmsford, Massachusetts.

When the arrays are delivered, the lower strut half is secured to the mullion, the mullion cover is snapped on, the array is lifted into placed, and the strut halves are bolted together. For maintenance or replacements, individual blades or an entire array may be removed without disturbing the building's occupants. Because it is relatively easy to make electrical interconnections between louvers and from array to array simply by using plug connectors, this can be called a "plug-n-play" type of installation and maintenance.

For the power hookup, leads were fed through window mullions into the building and to a Trace Engineering ST-1500 Inverter in the lobby, which is connected to a standard mechanical watt-hour meter. This was done not for billing but to educate visitors about PV power generation and the way that power is delivered to the building's electrical system. As part of a planned educational display, digital readouts calibrated in pounds of greenhouse gases will continuously update the emissions avoided by the solar system. At present, the system generates 3000-5000 watt-hours per day while shading offices from glaring sunlight.

"It's great to be on the cutting edge of a technology that will one day be available for all," said Mike Strobel, Contracting Officer, GSA Region 1.

For more information, contact Jeffrey Dewey, Acquest, 716-856-5100; e-mail: dewey@acquestdevelopment.com. ■

Solar Systems Flourish Among the Palms

By David Menicucci, Sandia National Laboratories

Staff at Sandia National Laboratories have been providing a wide variety of energy-saving assistance to the U.S. Marine Corps Air Ground Combat Center at 29 Palms, California. At Camp Wilson, 17 new solar hot water systems have been installed, saving 1,000 million British thermal units (Btu) of energy per year. At Mainside, Sandia led the refurbishment of non-operating solar hot water systems on the barracks, conserving another 2,500 million Btu annually. And at Range 500, Sandia assisted in diagnosing the problem with a 75-kilowatt photovoltaic system that runs tank targeting range and diagnostic equipment, saving 35 megawatt-hours of electricity per year. For more information, contact Dave Menicucci (e-mail: dfmenic@sandia.gov). ■

David Menicucci/PIX11060

A 75-kilowatt photovoltaic energy system is generating clean power in the desert near 29 Palms, California.

Solar/Hybrid System Reduces Noise, Emissions in Mt. Rainier National Park

By David Love, SunWize Technologies, Inc.

National Park Service (NPS) staff at Mt. Rainier National Park in Washington State will soon notice how quietly their electricity is being generated at the park's White River facility. A new 15.5-kilowatt (kW) solar photovoltaic (PV)/hybrid system, which includes a backup generator, will provide power for employee housing, water pumping, a ranger station, an entrance station, and tourist restrooms. More than 250,000 visitors pass through the area annually, from April to October.

The solar/hybrid system replaces a generator-only system, and the solar components now provide 85% of the facility's electricity. This reduces the generator's run time from about 3500 hours to only 150 hours per season. The facility's previous engine generator system ran 24 hours a day, subjecting residents in the housing units to noise and emissions.

SunWize Technologies, Inc., of Kingston, New York, designed, manufactured, and installed the remote PV/hybrid system, currently the largest of its kind in Washington State.

The system design was based on load data, supplied by NPS, of 59 kWh/day. The system is a 15.5-kW array of PV modules fixed at a 45-degree tilt and covering 90 linear feet of the roof of a new garage building. The system includes an industrial flooded battery bank and an on-demand AC propane generator. The total capacity of the battery bank is 3,332 amp hours at a 50-hour discharge rate, representing 4.3 days of autonomy. A 20-kVA inverter controls all system functions and inverts the 120 V DC from the battery bank to 120/208 V AC, 60 Hz, 3-phase electricity. The inverter includes an integral real-time data acquisition system and remote control capability that allows technical staff to monitor and control key system operating parameters from their Kingston, NY, headquarters. Lightning surge protection devices are provided in the combiner box, inverter input, genset input, and interface panel switch.

The inverter operates either as a stand-alone unit or in conjunction with the propane generator using an AC bus design to enhance system capacity. The unit can be configured as either a charger or inverter and will intelligently start and stop the generator if the battery reserve cannot be maintained by the solar system. The generator is optimally loaded to achieve a high fuel and operating efficiency. System operation is fully automatic with no break to the supply during transitions from the inverter to the engine generator.

As part of the project, NPS staff also improved energy conservation at the facility. They replaced lighting, refrigerators, and water pumps with more efficient models that reduce the load. On-site system training was provided to NPS staff. Project benefits include reduced fuel consumption, fewer emissions, less noise at employee housing, and lower annual operating costs. This system also helps NPS meet its goal of protecting the environment while serving the public.

Jim Fuller of the NPS said, "Even though the snow load was unusually heavy this past winter, the array was undamaged and, when not buried under snow, it generated power admirably. Our current load of 2 kW has been supported by solar without operating the generator. And we found the layout of components easy to work around."

For more information, please contact David Love, SunWize Technologies, 360-754-2564; e-mail: sunwizewa@earthlink.net. ■

SunWize Technologies-David Love/PIX11067

The National Park Service chose a hybrid energy system combining photovoltaics and a backup propane generator at Mt. Rainier National Park.

Technical Review: Field Experience with a PV/Fuel Cell System at Kirby Cove

By Andy Walker, National Renewable Energy Laboratory; Jim Christensen, National Park Service; Greg Barker, Mountain Energy Partners; and Lyle Rawlings, FIRST, Inc.

National Park Service (NPS) staff could have replaced an old power line with a new one at Kirby Cove Campground in Northern California's Golden Gate National Recreation Area. Instead, they decided to restore a hillside to its pristine appearance by removing the old line and installing a renewable power system. Because the power system is close to campers' tents in a national recreation area, they decided that it should be as clean and quiet as possible.

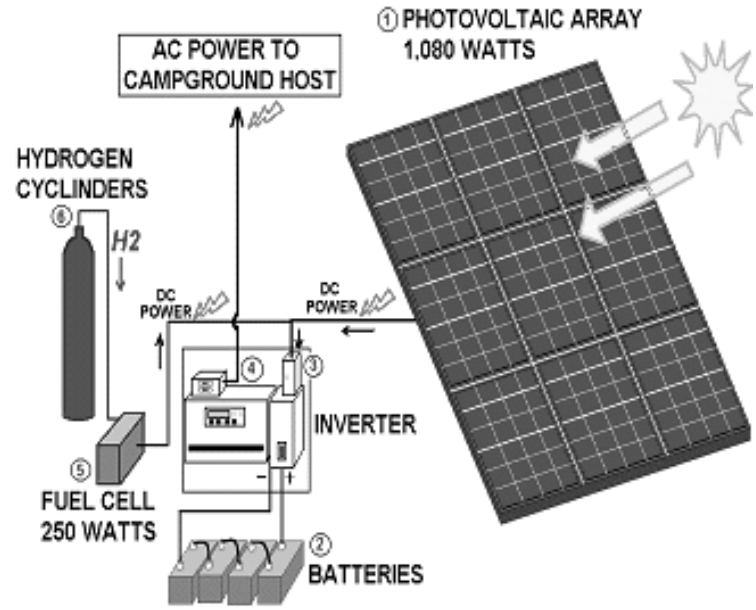
NPS staff selected photovoltaics (PV) to provide clean, silent solar electricity and chose a fuel cell system as backup. In June 1999, Fully Independent Residential Solar Technology, Inc., installed the hybrid PV/fuel cell system in collaboration with H-Power, Solar Depot, and Sun Pirates, Inc. The system cost $47,000, about $113,000 less than replacing the power line.

The hybrid system operated reliably from June 1999 to July 2001. During that time, power from both the PV system and the fuel cell met the campground host's load. Then in August 2001, reports of power outages prompted an in-depth investigation.

The PV system was designed to deliver 2 kilowatt-hours (kWh) per day, but actual use averaged 2.6 kWh/day. The fuel cell met loads exceeding the PV system's capability, and 22 cylinders of hydrogen were consumed from April to August 2001 (about one a week), at a delivered cost of $57.50 each. Each cylinder supplied the fuel cell for about 37 operating hours, delivering 9.3 kWh of electricity per cylinder. The cost indicates the value of meeting a limited load primarily with solar power, using a fuel cell only for backup.

The hybrid power system is in a 6-ft x10-ft campground shed. The 1,080-W PV array is mounted on the shed's roof; the 250-W fuel cell system, DC-to-AC power inverter, and batteries are inside. The array consists of nine Solarex MSX120 PV modules, each rated for 120 W under standard conditions. The modules are configured for a 24 V DC array. Co-extruded plastic covers were added to prevent vandalism. The covers have a 90% transmissivity but screen out the ultraviolet, somewhat reducing the PV output.

The fuel cell is an H-Power PS-250 Proton Exchange Membrane (PEM) system rated for 250 W DC, which includes the required pumps and controls. Fuel cells are electrochemical devices that convert chemical energy directly into electrical energy and heat, without combustion and thus few emissions. PEM fuel cells use a solid polymer membrane through which hydrogen nuclei (protons) carry a positive charge. The negative charge flows through an external circuit to deliver power. A PEM operates silently except for the hum of cooling fans and pumps delivering fuel and air. Although fuel cells cost more than conventional alternatives, they have environmental benefits and have been granted emissions exemptions in several air quality management districts.



The PV modules (1) generate 24 V DC power during the day, charging heavy-duty, deep-cycle batteries (2). A battery charge controller (3) shuts off modules when batteries are full. DC power from the batteries is converted to AC by the inverter (4). If there is not enough solar power for the home, the battery voltage falls below a setpoint and the fuel cell (5) turns on, drawing hydrogen from the cylinders (6) and converting its energy to 24 V DC power to charge the batteries. When battery voltage reaches an upper setpoint, the fuel cell turns off.

The total battery storage capacity is 18 kWh. A Trace 4024 inverter is mounted on a Trace power panel with disconnects and a charge controller. The entire hybrid power system provides 120 V AC power to a pedestal in the middle of the campground, used by the host.

When the system outages began, the load was disconnected because of low battery voltage eight times in a 14-day period. This loss of load usually occurred early in the morning before the PV array began producing power. During outages, the campground host received no power.

From September 2–15, 2001, the PV array supplied a total of 42.82 kWh. The fuel cell delivered 1.34 kWh, and net (out-in) energy from the battery totaled 6.82 kWh. After losses in the battery and inverter, energy delivered to the campground host totaled 34.94 kWh, an average of 2.6 kWh/day. The measured PV efficiency was 8.9%. When the fuel cell failed late in 2001, load exceeding the solar system's capability resulted in discharged batteries and eight power outages totaling 48 hours. The overall system availability was 85% when relying only on solar power. The inverter operated at a low fraction of its rated output (4 kW).

Inspecting the fuel cell system on December 21 and 27, 2001, researchers observed that its start-up procedure was repeating without continuous operation. After a burnt fuse was replaced, the fuel cell produced 125 W continuously but at a voltage too low to reliably charge the 24 V battery. Voltage measurements of each cell in the stack revealed several cells with 0.2 to 0.3 V instead of the rated 0.7 V. The researchers recommended that the fuel cell stack be repaired or replaced to restore the 28 V needed to charge the 24 V battery.

This investigation showed the importance of sizing a PV system properly to meet a load during normal operation; checking a fuel cell regularly; and keeping hydrogen fuel costs to a minimum. For more information, please contact Andy Walker, NREL; e-mail: andy_walker@nrel.gov.

Adapted and condensed from a paper to be presented June 15-20, 2002, at Solar 2002: Sunrise on the Reliable Energy Economy, *Reno, Nevada.* ■

Monitoring Earthquakes with PV at USGS

By Jennifer Sponseller, Schott Applied Power Company

John Galetzka of the United States Geological Survey (USGS) in Pasadena, California, had a problem: he needed electricity for earthquake movement monitoring instruments. And the instruments are in places where there is no grid power. These instruments measure the movement of the Earth's plates in millimeters. The measurements indicate the subtle flexing that occurs just before shattering—that is, just before an earthquake occurs. Data are transmitted by radio or via a satellite, like the one on Guadalupe Island off the western coast of Mexico.

Galetzka turned to Schott Applied Power for a custom-designed Modular Autonomous PV Power Supply (MAPPS)™ solar power system. MAPPS are currently the only UL-listed systems of their kind available. Several hundred MAPPS systems have been deployed in Southern California, and following the recent earthquake, in the Olympic Peninsula area of Washington State. " The MAPPS systems are easy to install, completely turnkey, and extremely durable and reliable," Galetzka said.

For more information, please contact Jennifer Sponseller, Schott Applied Power, 916-625-9033, ext.1406; e-mail: jennifer.sponseller@us.schott.com. ■

Schott Applied Power Corp./PIX11068

This earthquake-monitoring system operates on solar power.

Upcoming Events and Conferences

June 2002

Energy 2002: Hot Challenges, Cool Solutions, June 2–5, 2002; Palm Springs, CA
The fifth annual national energy management workshop and trade show, sponsored by the U.S. Department of Energy's Federal Energy Management Program. For more information:
Joann Stirling
Phone: 800-395-8574
E-mail: meetings@sae.org
Web site: *www.energy2002.ee.doe.gov*

WINDPOWER 2002, June 2–5, 2002; Portland, OR
The largest wind conference in North America, providing the latest industry trends, technologies, and renewable energy policy developments. For more information:
American Wind Energy Association (AWEA)
Phone: 202-383-2500
Web site: *www.awea.org/events/*

SOLAR 2002—Sunrise on the Reliable Energy Economy, June 15–20, 2002; Reno, NV
Covering solar energy-related disciplines and the technological, infrastructural, and political issues affecting them. For more information:
American Solar Energy Society (ASES)
Marion Barritt, Chair, Solar 2002
Phone: 775-782-7353
E-mail: mbarritt@powernet.net
Web site: *www.solarenergyforum.org*

Mid-Atlantic Sustainability Conference: Energy, Buildings, and the Bottom Line, June 26–29, 2002; Rutgers University, Newark, NJ
Bringing together leaders in energy-efficient design, renewable energy generation, high-performance school construction, and land-use planning. For more information:
Northeast Sustainable Energy Association
Phone: 413-774-6051
Web site: *www.nesea.org*

July

Fundamentals of Power Quality, July 10–12, 2002; Lake Tahoe, NV
For more information:
Association of Energy Engineers, AEE Energy Seminars
P.O. Box 1026
Lilburn, GA, 30048
Phone: 770-925-9633
Web site: *www.aeecenter.org*

August

5th International Meeting on Electrochromism, August 6–9, 2002; Golden, CO
Presenting information on electrochromic materials being developed for future products such as "smart" window glazing for buildings. For more information:
Megan Maguire
Phone: 303-275-4321
E-mail: megan_maguire@nrel.gov
Web site: *www.nrel.gov/events.html*

September

Solar Decathlon, September–October, 2002; National Mall in Washington, DC
In a collegiate competition, architecture and engineering students design and construct model houses powered by the sun; sponsors include the U.S. Department of Energy, NREL, BP Solar, EDS, and Home Depot. For more information:
Dr. Richard King, U.S. Department of Energy
Phone: 202-586-1693
E-mail: Richard.king@ee.doe.gov
Web site: *www.solardecathlon.org*

MicroGeneration to PowerParks 2002, September 22–25, 2002; Detroit, MI
Presented by the Great Lakes Renewable Energy Association, ESD–The Engineering Society, and the Institute of Public Utilities; addresses issues, policies, and practices that influence the successful commercialization of renewable and distributed generation technologies. For more information:
Phone: 800-434-9788
E-mail: info@glrea.org
Web site: *www.glrea.org/mgpp.html*

October

Excellence in Building 2002 Conference and Exposition, October 9–12, 2002; Phoenix, AZ
Since 1982, a leading forum on best building practices, recognized for quality in the field of energy and resource efficiency. For more information:
Phone: 952-881-1098
E-mail: info@eeba.org
Web site: *www.eeba.org/conference/*

November

UPEx'02, The Photovoltaic Experience Conference, November 12–15, 2002; Austin, TX
Brings together utility representatives, energy service providers, manufacturers, architects, builders, researchers, and others. For more information:
The Solar Electric Power Association
Phone: 202-857-0898
E-mail: SolarElectricPower@ttcorp.com
Web site: *www.solarelectricpower.org/*

Save with Solar & Wind

Save with Solar and Wind: A Technical Bulletin for Federal Solar and Wind Energy Champions

Annett Eiffert, Editor

Production editor: Paula Pitchford
Graphic designer: Jim Miller

Produced for the
U.S. Department of Energy (DOE)
Federal Energy Management Program
by the National Renewable Energy
Laboratory, a DOE national laboratory

DOE/GO-102002-1591
Revised June 2002

Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste

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FEMP Help Desk:
1-800-363-3732
On the Web: www.eren.doe.gov/femp

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Smithsonian Lab Designed for Total Independence

By Clare Miflin, Kiss + Cathcart, Architects

The Smithsonian Institution is starting construction on one of the first research laboratories in the world to be totally self-sufficient, collecting all of its own energy and water and emitting no waste. Although it will be connected to utilities at the site, the marine biology laboratory at the Smithsonian Tropical Research Institute in Panama is designed to consume "zero net" energy and water. The Smithsonian's Melinda Humphry Becker (in Washington, DC) and Fernando Pascal (in Panama) commissioned Kiss + Cathcart, Architects, along with Arup Consulting Engineers, to design it.

The interior volumes are set on top of a raised concrete slab and shaded by a double roof to minimize solar gain, collect rainwater, and provide shaded, outdoor working spaces. The south-facing roof consists of a large, integrated photovoltaic system that supplies the electricity needs of the building. Air conditioning will be made more efficient by the use of heat-exchange coils in the ocean, and waste will be treated by composting toilets and a constructed wetland.

Melinda Humphry Becker, Senior Design Manager for the Smithsonian, said, "The Smithsonian Institution and Tropical Research Institute are excited to be creating one of the first zero-impact buildings anywhere. The challenges of doing this in a hot, humid and remote location, for a demanding building type—a laboratory—have been great, but working with a design team with proven sustainable expertise has enabled us to minimize environmental impact while providing an exemplary scientific facility."

For more information, please contact Clare Miflin, Kiss + Cathcart, Architects, 718-237-2786; e-mail: c.miflin@kisscathcart.com. ■

Kiss + Cathcart Architects/PIX11069