Career currents

Exploring Today's Energy Careers with the NEED Project Vol. 1, No. 4 April 2006

Solar Energy Benefits Tribal Homes

Until recently, Navajo families in parts of Arizona, New Mexico, Utah and Colorado lived too far from established power grids to receive electricity in their homes. "Bringing the energy to them would have cost $27,000 per mile, far more than tribe members could afford," says Native American civil engineer Sandra Begay-Campbell. Some families live more than ten miles from the nearest grid connection! With assistance from the Department of Energy's Tribal Energy Program, Sandra helps the Navajo Tribal Utility Authority place solar units on individual homes to generate electricity. For many, it's the first time they've had electricity in their homes.

Sandra currently works as a **Civil Engineer** for Sandia National Laboratories. She leads the technical efforts in the Renewable Energy Program to assist tribes with renewable energy development. Sandra gives technical advice to tribal governments that receive Department of Energy (DOE) grants.

As a member of the Navajo Nation, Sandra's perspective incorporates her cultural values into a technical environment. Sandra says, "I get to work with my own native people. I give them a new way to think about having electricity. It's very rewarding."

Credit: U.S. Department of Energy

The Navajo Utility Authority, with DOE funding, has installed PV units at more than 300 homes on the reservation since 1993. But there is still a long way to go. It is estimated that 18,000 families in the Navajo Nation live without electricity today.

Credit: U.S. Department of Energy

Debby Tewa spent the first ten years of her life living without electricity, water or a telephone in an isolated area of the Hopi Reservation in Arizona. Today, working alongside Sandra Begay-Campbell with the Tribal Energy Program, she provides technical advice to people on Indian reservations about maintaining photovoltaic electricity units.

Learn more about the work of these women in these resources: "Changing Our World: True Stories of Women Engineers" by Sybil E. Hatch; the National Academy of Engineering's website, www.engineergirl.org; and the National Nuclear Security Administration's January 2006 newsletter, found at www.nnsa.doe.gov.

In This Issue

Career Currents provides educators and students with resources to introduce energy careers. Each issue of *Career Currents* focuses on a different sector of the energy industry. No single issue is meant to be all-inclusive to either the sector profiled or all careers in energy. This issue focuses on careers in the solar industry.

The NEED Project

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NEED welcomes your questions, comments, and suggestions. Please contact info@need.org.

College is an Opportunity to Explore a Career in Solar Energy

Where can you go to get a degree in renewable energy? Only a few universities offer programs that study renewable energy or sustainable technologies. Here are three programs that specialize in solar energy:

Appalachian State University (ASU) in Boone, North Carolina, is the only U.S. university to offer bachelor's and master's degrees in Technology, with a concentration in Appropriate Technology. Areas of study include wind power, solar energy applications, photovoltaics (PV), hydroelectric power, green building techniques and technologies, sustainable transportation, resource management, and organic and sustainable agriculture. Besides courses, hands-on research projects and extra-curricular activities provide amazing opportunities for students to learn outside the classroom. For example, students may design and install solar water heating systems, install and maintain PV systems, design and build alternative-fueled vehicles, or use solar energy to dry food and lumber or distill and pasteurize water. These research projects are carried out both locally and internationally. ASU has a very active Solar Club, which is a chapter of the American Solar Energy Society (ASES). For more information about the Appropriate Technology degree programs offered at Appalachian State University, visit www.tec.appstate.edu.

The **Renewable Energy Technician** option offered within the Energy Management Program at **Lane Community College** in Oregon is a professional technical program that prepares students for employment designing and installing solar electric and domestic hot water systems. Lane has a complete two-year degree curriculum in commercial energy efficiency. Students in the renewable program are given a solid background in residential energy efficiency, heating, ventilation, air conditioning and cooling (HVAC) systems, lighting, physics, math, electricity fundamentals and energy economics. Students learn to design and install systems by assembling and testing systems on racks in a lab environment and, ultimately, moving outside to "live" installations where they place PV and domestic hot water systems on residential and commercial buildings. For more information, visit Lane Community College's website, www.lanecc.edu/instadv/catalog/science/programs/energy.htm.

San Juan College in Farmington, New Mexico offers a concentration in Photovoltaic System Design and Installation as a 1-year certificate or a 2-year Associate of Applied Science degree with the same technical content. The renewable energy program gives students a solid foundation in the fundamental physics and design/installation techniques required to work with renewable technologies. For information, visit the college's website, www.sanjuancollege.edu/academics/technology/RENG/index.htm.

Sources: Interstate Renewable Energy Council memo, "Occupational Profiles for the Solar Industry" at www.irecusa.org, and M. Sagrillo, "Earning a degree in RE," SOLAR TODAY, September/October 2005 (article also available at www.solartoday.org).

Energy Career Chat

Career Currents chats with Thomas Honey, owner of Honey Electric Solar, Inc. in Liberty, North Carolina.

***Career Currents*:** How did you get interested in solar energy?

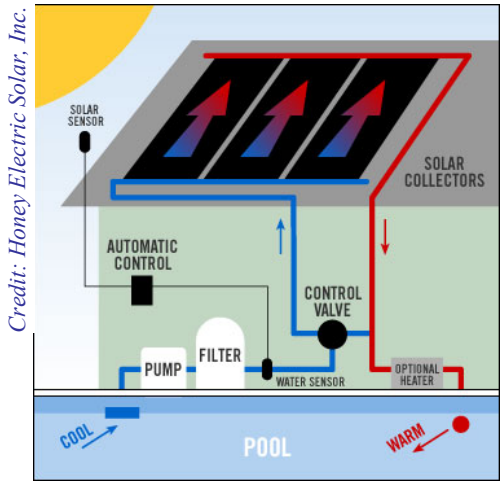
Thomas Honey: My parents had a solar water heater installed on their home in the 80's. I thought solar thermal made a lot of sense, so I studied the concept and then decided to make it my business.

CC: Tell us about your business.

TH: Honey Electric Solar was founded in 1994 and is the premier dealer/installer of photovoltaic (PV) systems and solar swimming pool heating and solar water heating equipment in North Carolina. Energy production is one of the world's most pressing needs; solar systems produce lots of energy and, therefore, are becoming a mainstream technology today. Our goal is to help people gather their own energy from the sun, thereby decreasing the environmental impact of homes and lifestyles.

CC: What types of installations do you do, and where do you put them?

TH: We install solar pool heaters, water heaters and PV systems. We install both residential and commercial. Most solar is installed on roof structures, but pole and ground mountings are also options. The collectors need to be installed where they can be in the sun a good portion of the day, usually facing south.



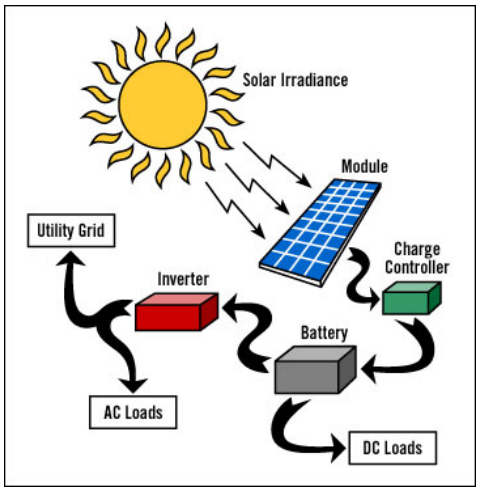
Credit: Honey Electric Solar, Inc.

CC: Explain how solar swimming pool heating works.

TH: Using the pool's pump, water is circulated through hundreds of specially designed channels in the solar collectors. Pool water is heated inside the solar collectors and returned to the pool through existing piping.

CC: Tell us about the PV systems you install.

TH: Converting sunlight directly into electricity is an environmentally friendly way to produce energy. Solar PV systems require no moving parts, need little maintenance, use no fuel and produce no pollution.



Credit: Honey Electric Solar, Inc.

A single solar cell will produce 0.5 volts direct current (dc). A module, which is several solar cells tied together, can produce a dc voltage from 12 to 600 volts. These PV modules can be wired together to produce PV circuits (strings) of a variety of voltages. One or more strings wired together create a photovoltaic array. The more sunlight solar modules receive the more power they will produce. A charge controller regulates the voltage and current coming from the solar panels going into the rest of the PV system. Solar electricity can be used directly to run dc motors or it may be stored in batteries for later use. An inverter converts dc voltage instantly into alternating current (ac) voltage which can power common tools and appliances or be net metered into the utility grid.

CC: What training do you need to work as a solar installer?

TH: Installers should have a strong mechanical aptitude and be self starters. Electrical and plumbing skills are a plus in this construction related field.

CC: What is the most rewarding part of your job?

TH: Turning on a new installation and collecting the final payment.

To learn more about Thomas Honey's business, Honey Electric Solar, Inc., visit www.honeyelectricsolar.com.


Credit: Honey Electric Solar, Inc.

Solar Energy Technologies

The Department of Energy's Solar Energy Technology Program develops solar energy technologies to power our world and educates the public on the value of solar as a secure, reliable and clean energy choice. Solar energy technologies have great potential to benefit our nation. They can diversify our energy supply, reduce our dependence on imported fuels, improve the quality of the air we breathe, offset greenhouse gas emissions, and stimulate our economy by creating jobs in the manufacturing and installation of solar energy systems.

The program focuses on four areas: *photovoltaic (solar cell) systems*, which produce electricity directly from sunlight; *concentrating solar power systems*, which convert solar energy into heat to produce electricity; *passive solar heating and daylighting*, which use solar energy to heat and light buildings; and *solar hot water*, which heats water with solar energy.

Photovoltaics

Solar cells, also called photovoltaics (PV) by solar cell scientists, convert sunlight directly into electricity. Solar cells are often used to power calculators and watches. They are made of semiconducting materials similar to those used in computer chips. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting radiant energy to electrical energy is called the *photovoltaic (PV) effect*.

Thin film solar cells use layers of semiconductor materials only a few micrometers thick. Thin film technology has made it possible for solar cells to double as rooftop shingles, roof tiles, building facades, or glazing for skylights or atria.

Credit: U.S. Department of Energy

These roof shingles are actually PV cells made of amorphous silicon. PV shingles offer the same protection and durability as ordinary asphalt shingles, but they generate electricity.

Concentrating Solar Power

There are three main types of concentrating solar power (CSP) systems: *parabolic-trough*, *dish/engine* and *power tower*.

Credit: U.S. Department of Energy

Parabolic-trough system.

A parabolic-trough system concentrates the sun's energy through long rectangular, curved (U-shaped) mirrors. The mirrors are tilted toward the sun, focusing sunlight on a pipe that runs down the center of the trough. This heats oil flowing through the pipe. The hot oil boils water in a conventional steam generator to produce electricity.

Credit: Dept. of Energy

Power tower system.

A dish/engine system uses a mirrored dish (similar to a very large satellite dish). The dish-shaped surface collects and concentrates the sun's energy onto a receiver, which absorbs light and converts it to heat. The heat transfers to fluid within the engine, causing the fluid to expand against a piston or turbine, and produces mechanical power. The mechanical power runs a generator or alternator to produce electricity.

Credit: Sandia National Labs

Dish/engine system.

A power tower system uses a large field of mirrors to concentrate sunlight onto a receiver on top of a tower. This heats molten salt flowing through the receiver. The salt's heat is used to generate electricity through a conventional steam generator. Molten salt retains heat efficiently, so it can be stored for days before being converted into electricity. That means electricity can be produced on cloudy days or even several hours after sunset.

Passive Solar Heating and Daylighting

Many buildings are designed to take advantage of the sun's energy through the use of passive solar heating and daylighting. In the U.S., the south side of a building always receives the most sunlight, so buildings designed for passive solar heating usually have large, south-facing windows. Materials that absorb and store the sun's energy as heat can be built into the sunlit floors and walls. The floors and walls heat up during the day and slowly release heat at night, when the heat is needed most. This passive solar design feature is called *direct gain*.

Other passive solar heating design features include *sunspaces* and *trombe walls*. A sunspace (like a greenhouse) is built on the south side of a building. As sunlight passes through glass, it heats the sunspace. Proper ventilation allows the heat to circulate into the building.

A trombe wall is a very thick, south-facing wall, painted black and made of a material that absorbs radiant energy. A pane of glass or plastic glazing, installed a few inches in front of the wall, helps hold in heat. The wall heats up slowly during the day. As the wall cools gradually during the night, it gives off its heat inside the building.

Credit: U.S. Dept. of Energy

Clerestory windows provide daylighting for workers in this building.

Many passive solar heating design features also provide daylighting. *Daylighting* is the use of natural sunlight in a building's interior. A *clerestory* is a row of windows near the peak of the roof. This is often used along with an open floor plan, allowing light to bounce throughout a building.

Credit: U.S. Department of Energy

This sky simulator provides a test facility for researchers and building design professionals to conduct model studies on daylighting.

Solar Hot Water

Most solar water heating systems for buildings have two main parts: a solar collector and a storage tank. A *flat-plate collector* mounted on the roof consists of a thin, flat, rectangular box with a transparent cover that faces the sun. Small tubes run through the box and carry the fluid (either water or an antifreeze solution) to be heated. The tubes are attached to an absorber plate, which is painted black to absorb radiant energy. As heat builds up in the collector, it heats the fluid passing through the tubes. A well insulated storage tank holds the hot liquid.

Solar water heating systems can be either active or passive. Active systems rely on pumps to move the liquid between the collector and the storage tank, while passive systems rely on gravity and convection (the tendency for water to naturally circulate as it is heated).

Jobs in Solar Power

Growth of the solar power industry creates high-wage, skilled jobs throughout the country for individuals with many different types of training. National laboratories, universities, and private companies develop and continually improve solar products to lower their costs and improve their reliability. Individuals employed in solar research and development (R&D) generally have professional degrees in electrical, mechanical or chemical engineering, materials science or physics.

As each technology progresses from the research and development phase toward full-scale commercialization, an increasing number of professional and skilled workers are needed to sell, manufacture, design, install and maintain equipment. The PV and solar hot water industries currently employ the majority of these workers, including **Electricians**, **Engineers**, **Technicians** and **Technical Managers**. As utility-scale concentrated solar power (CSP) technologies become commercially viable, the CSP industry will require an increasing number of specialized workers, as well as engineers and **Construction Workers** to design and build power plants. The passive solar industry involves many of these professions as well, but also employs **Architects** and **Builders**.

For information on solar technologies, visit www1.eere.energy.gov/solar.

The most recent technology, *hybrid solar lighting (HSL)*, collects sunlight and routs it through optical fibers into buildings where it is combined with electric light in hybrid light fixtures. Sensors keep the room at a steady lighting level by adjusting the electric lights based on the sunlight available. This new generation of solar lighting combines both electric and solar power. Hybrid solar lighting pipes sunlight directly to the light fixture, and no energy conversions are necessary; therefore the process is much more efficient.

HSL does not waste any portion of the sunlight. It delivers the visible portion of sunlight deep into the building to provide interior lighting, and it uses the remaining portion of the sunlight (outside of the visible spectrum) to generate electricity.

The natural and electric light sources work in unison to illuminate the inside of buildings. Lighting controls automatically reduce the amount of electric light used in accordance with the amount of sunlight that is available. In addition to being more efficient than commercially available solar options, hybrid solar lighting brings highly preferred, full-spectrum sunlight inside buildings.

Solar Industry Careers

The Solar Industry Composes a Very Diverse Group

Solar Cell and **Module Manufacturers** build crystalline, thin-film and concentrator products.

Photovoltaic Equipment Manufacturers design and supply equipment to fabricate devices, assemble modules and test products.

Balance of Systems (BOS) Manufacturers and **Suppliers** design, develop and fabricate equipment, electronics, and devices to monitor, control, ensure quality, store and provide a utility interface to the electrical power produced by photovoltaic modules.

System Integrators, **Packagers** and **Installers** work with consumers, microgrids and power parks, and utilities for central-station and distributed-generation applications. They provide skilled labor to mount, monitor and maintain systems.

Researchers and **Scientists**

Engineers

Technicians

Some Occupations in the Solar Industry

Solar Consultants advise people on the type and size of solar system that would work best in their homes or businesses.

Solar Architects and **Designers** design buildings to most efficiently use the sun's energy.

Solar Builders construct buildings with passive and active solar designs.

Lead PV Installers are responsible for leading teams in residential and commercial PV system installation, troubleshooting and repair.

Manufacturing Engineers evaluate, troubleshoot, validate, and improve manufacturing processes, products and equipment.

Senior Production Planners are responsible for all aspects of purchasing electronic and mechanical components and products.

Solar Cell and **Panel Inspectors** handle and inspect solar cells, panels and electromechanical devices, following engineering specifications and drawings.

Inverter Repair Technicians may work in factory authorized service centers. They are experienced in electronic repair, dc to ac conversion technology and alternative energy systems.

Electrical Test Technicians perform the set-up, calibration, testing and troubleshooting of power inverters, instruments and electro-mechanical assemblies.

Salespersons are responsible for all facets of commercial photovoltaic (PV) system sales including performing sales presentations, customer prospecting, generating quotes, accessing available rebates and incentives, and creating, reporting and meeting sales goals. In addition, they serve as liaisons to commercial and political organizations, attend trade shows and conferences, and give interviews to local and state press.

Entry-Level Solar Installers/Technicians are responsible for project installations, service and shop maintenance. They have experience in electrical wiring and construction, have a working knowledge of roof and ladder safety, and are comfortable working at heights. They receive training in solar technology and installation methods, and have the opportunity to work on both the mechanical and electrical side of installing solar PV systems. Installers may work in teams of four, servicing both residential and commercial installations, possibly on an alternative work schedule (four ten-hour days). Workers may be required to provide their own hand tools. This physically demanding job requires some heavy lifting and work in extreme environments. Solar Installers/Technicians start at $15 per hour. A high school diploma is required, but a two-year degree in technology/industrial arts is preferred.

Credit: Honey Electric Solar, Inc.

Occupations Indirectly Related to the Solar Industry

Skilled Laborers - roofers, electrical and metal workers, machinists and transportation engineers.

Commodity Suppliers - glass industry, electronic device manufacturers, plastics and polymer industries, equipment suppliers, wire and cable makers, and the steel, aluminum and other metal industries.

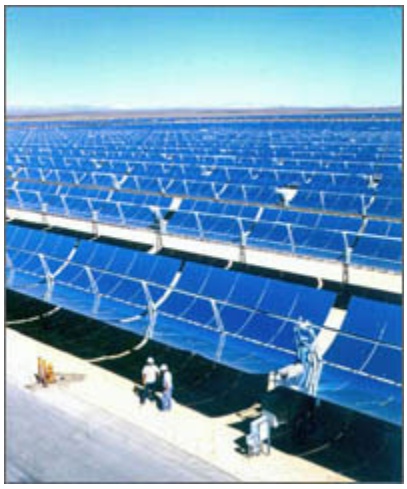
Electric Power Utility Workers

Information from the Interstate Renewable Energy Council memo, "Occupational Profiles for the Solar Industry," www.irecusa.org.

Solar Energy Information & Career Resources

- The 2006 National Solar Conference will be held in Denver, Colorado on July 8-13, 2006 – www.solar2006.org.
- The American Solar Energy Society (ASES) – www.ases.org. ASES publishes *SOLAR TODAY* magazine – www.solartoday.org.
- Andy Black, "Finding Your Dream Job in Solar. How to build the skills, experience and connections that will give you an edge." *SOLAR TODAY*, September/October 2005, pp.20-23 (also available at www.solartoday.org).
- The Bureau of Labor Statistics offers young people an opportunity to explore a variety of careers at www.bls.gov/k12/index.htm.
- The Department of Energy offers a glossary of solar terms at www1.eere.energy.gov/solar/solar_glossary.html.
- The Impression5 Science Center of Michigan's website, www.impression5.org/solarenergy, explains the basics of solar energy, electricity and conservation, and includes a fun solar energy quiz.
- The Interstate Renewable Energy Council (IREC) – www.irecusa.org.
- The JETS' website, www.jets.org, includes resources, articles, and activities about engineering and technology careers.
- The National Center for Photovoltaics – www.nrel.gov/ncpv.
- The National Renewable Energy Laboratory (NREL) – www.nrel.gov.
- Renewable Energy Access – www.renewableenergyaccess.com.
- The Solar Decathlon program has compiled an extensive list of solar energy teaching resources at www.eere.energy.gov/solar_decathlon/for_teachers.html.
- The Solar Energy Industries Association (SEIA) – www.seia.org.
- The Solar Electric Power Association (SEPA) – www.solarelectricpower.org.

The U.S. Department of Energy is home to America's national labs, where 30,000 scientists and engineers work to secure our energy, economic and national security through cutting-edge technology.



Credit: U.S. Department of Energy

The United State's largest solar power facility, near Kramer Junction, California, consists of five solar electric generating stations with a combined capacity of 150 megawatts, which is usually enough power for about 150,000 homes. The facility covers more than 1,000 acres and has a collector surface area of more than a million square meters.

Hey Bookworms…

Sybil E. Hatch, "Changing Our World: True Stories of Women Engineers," American Society of Civil Engineers, c.2006.

ISBN 0-7844-0841-6
TA157.H4155
$49.00, available at www.pubs.asce.org

Through real-life stories, this full-color, 256-page book explores the many achievements of women in engineering, including pioneers and modern day women. These role models have some amazing jobs – from astronauts to Hollywood movie makers. This book highlights careers in areas of bioengineering, agriculture and food, shelter and community, environment, transportation, telecommunications, electricity, entertainment, flight, space and defense.

This book was developed and published as a collaborative effort among major engineering society presidents, who, for the first time in history, were all women. Their work on the project has been formalized into the Extraordinary Women Engineers Projects for which First Lady Laura Bush serves as honorary chair. For more information on the project, visit www.engineeringwomen.org.

Solar Decathlon

The Solar Decathlon is a competition sponsored by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy. Teams of college and university students from around the globe participate in the competition to design, build, and operate the most attractive and energy-efficient solar-powered home. Each team receives $100,000 to support the Solar Decathlon's research goal of reducing the cost of solar-powered homes and advancing solar technology.

Credit: U.S. Department of Energy

With an eye on energy efficiency, students carefully choose the systems, products and appliances used in their houses. Each team spends two years designing and building an 800-square-foot home and preparing for the 10 day competition. The teams transport their solar houses to the National Mall in Washington, D.C., where they form a solar village, which is open to the public and the media.

To compete in the Solar Decathlon competition, the teams must design and build homes that are powered exclusively by the sun. The homes must provide enough solar power to wash clothes, run a dishwasher, power computers and maintain a comfortable temperature. Each team is judged on its solar home's architecture, livability, comfort, and ability to provide a consistent supply of electricity to run appliances, provide ample lighting, charge an electric car and supply hot water for daily use. In addition to the design and energy-related requirements of the competition, teams must also provide documentation about the development of the design of their homes and communicate about their homes to the public.

The University of Colorado, Denver and Boulder, took first place in Solar Decathlon 2005 (pictured above). Planning for the Solar Decathlon 2007 has already begun. For more information, visit www.eere.energy.gov/solar_decathlon.

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