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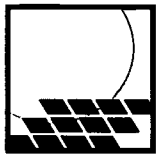
ABSTRACT

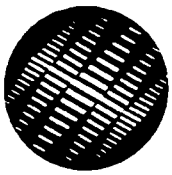
Schools today are hosting the solar energy systems that will become commonplace tomorrow in public buildings, homes, and businesses. This publication serves as a guide to how schools are using solar energy, listing scores of schools currently using the sun for lighting, heating, and cooling as well as highlights of innovative programs to expand the use of solar energy. Contains a list of resources for further investigation. (Author/NB)

SchoolsGoingSolar

A Guide to Schools Enjoying the Power Of Solar Energy



The Utility PhotoVoltaic Group (UPVG)
is an association of 90 energy service providers from the U.S., Canada, Europe, the Caribbean, and Australia, as well as 53 subscribing companies and organizations. UPVG members are cooperating to help accelerate and expand the commercial use of solar photovoltaic electricity. UPVG manages TEAM-UP, a solar commercialization program, and provides timely information on market developments to its members, subscribers, and the general public.



The Interstate Renewable Energy Council (IREC)
is a national, not-for-profit organization which supports market-oriented services targeted at education, coordination, procurement, technology transfer, and linkage with national laboratories, industry associations, and other renewable energy organizations. IREC's members include state energy offices, other municipal and state agencies, national laboratories, solar and renewable organizations, private companies, and individual members.

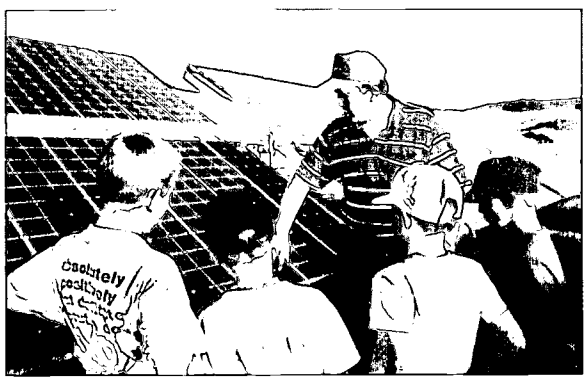
The American Solar Energy Society (ASES)
is the national individual membership organization dedicated to promoting solar energy technologies. ASES has over 6,000 members and is known and respected as a source of credible information on solar energy by members, energy-related professionals, industry and government leaders, environmental leaders, the media and the general public. ASES has 18 state and regional chapters across the United States.

This publication was prepared for the Going Solar campaign by the communications staff of the Utility PhotoVoltaic Group: Bob Gibson, Jenna Mayotte, Jacquie Cochran, and Seth Kalish (design).

Additional planning and research was contributed by Jane Weissman (Interstate Renewable Energy Council), Peggy Plate (Western Area Power Administration), Susan LeFever (American Solar Energy Society), and David Warner (National Renewable Energy Laboratory). Thanks to Michael Totten (Center for Renewable Energy and Sustainable Technology), Roy Johannesen (SolMates Foundations), Hector Ibarra (West Branch, Iowa, Middle School) and everyone else who contributed information and photographs of Schools Going Solar.

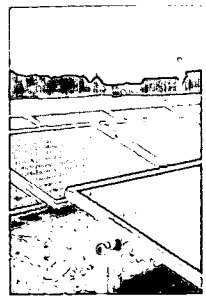
Schools Going **Solar**

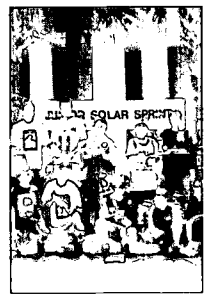
Schools today are hosting the solar energy systems that will become commonplace tomorrow in public buildings, homes, and businesses. This publication serves as a guide to how schools are using solar energy, listing scores of schools currently using the sun for lighting, heating, and cooling, as well as highlights on innovative programs to expand the use of solar and a list of resources for further exploration.

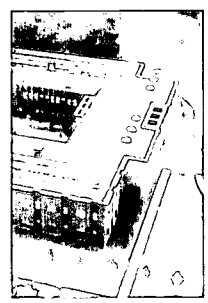


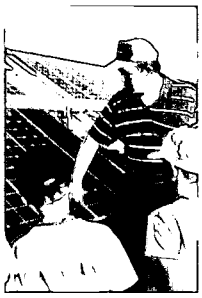
Photovoltaic cells made of silicon can convert the sun's rays to electricity.

Bringing solar to schools is an important first step to increasing the use of solar energy in the community at large. Schools make an excellent showcase for the benefits of solar photovoltaic electricity, solar thermal energy, and passive solar. Changes and improvements at schools are highly visible and closely followed. As has been the case with recycling programs, which were introduced to many communities by schoolchildren educating their parents, students can carry good ideas from the fringe into the mainstream.







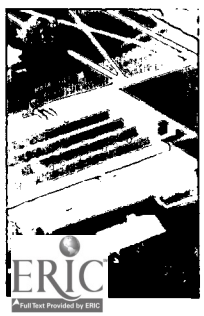


Demand for energy continues to grow worldwide, but sources of the combustible fuels we depend upon, such as coal, oil, and gas, are finite. In addition, the increased burning of fossil fuels raises concerns over global warming and, where controls are lax, air pollution.

Solar energy, clean and limitless, can meet new energy demands. What is needed is more widespread use of solar technologies, both to get people familiar and comfortable with solar and to achieve the economies of scale needed to bring manufacturing prices down.

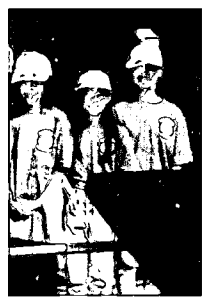
The Million Solar Roofs Initiative, announced in June, 1997, by President Clinton, has helped give solar a public boost. The Initiative calls for the U.S. government to partner with the private sector—communities, utilities, manufacturers, and others—to install solar energy systems on one million rooftops by the year 2010.

Physically, schools are an ideal place to use solar energy. The energy demand in school buildings is significant and concentrated during the daytime,



when the energy from the sun can be used to maximum benefit. The value of solar is multiplied when using different solar technologies in concert and in combination with other new and efficient uses of resources, including low-wattage lighting, heat pumps, and better insulating windows, walls, and roofs.

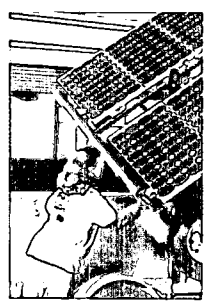
Schools are choosing to go solar to solve a number of energy needs, from powering school zone flashers and safety lights to heating hot water to bringing natural daylight to classrooms to reducing consumption of fossil fuels. Utilities site solar photovoltaic systems on schools as a part of "green pricing" programs (voluntary programs where consumers pay a little extra to support renewable energy use) that offer customers an affordable means of supporting the use of solar power. State governments promote a variety of solar school programs with an eye to developing new energy resources to reduce public expenditures.



In many of the cases where schools are using solar energy, they are also studying the benefits and output of the solar technology, often as a formal addition to science classes or after-school programs.

***Schools* Going Solar** is produced as part of an ongoing **Going Solar** public education campaign conducted by three nonprofit organizations—the Interstate Renewable Energy Council, the Utility PhotoVoltaic Group, and the American Solar Energy Society. The **Going Solar** campaign appreciates receiving news, information, and photographs about solar energy in schools and installations not covered in this first edition of ***Schools* Going Solar**.

The **Going Solar** collaborative campaign gratefully acknowledges the funding and support provided by the U.S. Department of Energy.



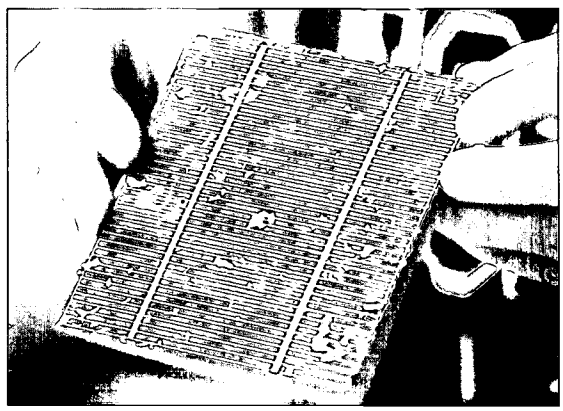
Solar ABCs

Photovoltaics

...more commonly known as solar electricity

In 1839, Edmund Becquerel noticed that the sunlight absorbed by certain materials can produce, in addition to heat, small quantities of electricity. This curious phenomenon was limited to measuring light levels in photography until the 1950s. Then, improved purification techniques, advances in solid-state devices, and the needs of the emerging space program led to the development of photovoltaic cells.

Photovoltaic cells convert sunlight directly into electricity. When sunlight strikes a PV cell, usually made of silicon that's been chemically treated, an electron is dislodged. (Silicon is the same stuff as sand at the beach and is found all over the world.) These loose electrons are gathered by wires attached to the cell, forming an electrical current. The more cells added, the higher the current and voltage. A number of PV cells laid side-by-side form a rectangular "module"; several modules together form an "array."



Most commonly known as "solar cells," PV systems are already an important part of our lives. The simplest systems power many of the small calculators and wrist watches in use every day. More complicated systems provide electricity for pumping water, powering communications equipment, and even lighting homes and running appliances. In a surprising number of cases, PV power is the cheapest form of electricity for performing these tasks.

Solar electricity is being used in schools around the country not only to generate electricity but to educate students in alternative forms of energy production and possibly guide the next generation to careers in the energy field.

Passive Solar

"Passive solar" uses the sun for lighting and its warmth for heating without the aid of a mechanical device. Passive solar technologies save energy because less energy is needed for lighting and heating when the sun pitches in. Tests conducted by the National Renewable

Energy Laboratory show that buildings with passive solar design (sometimes called "climate-responsive" buildings) use 47 percent less energy than conventional new buildings and 60 percent less than comparable older buildings. The use of "daylighting" not only decreases the amount of electricity used for lighting (which is frequently the greatest expenditure for large buildings), but makes people feel healthier.

A passive solar building in the Northern Hemisphere would be oriented with most of its windows facing south in order to capture the most daylight during the day (and small or no windows on the north side to decrease heat loss). Sunlight also heats surfaces it hits (called "passive solar thermal"). This heat can be used to heat water (typically the greatest energy expenditure in homes) or "collected" by a solid wall or floor, to be released slowly after the sun sets.

Buildings employing passive solar design might include skylights, uncovered "clerestory" windows high across a wall to increase the amount of light inside, "light shelves" along high windows to "bounce" sunlight into the darker interior, broad eaves overhanging windows to keep out the hot summer sun when it is high in the sky, systems to hold water on rooftops where it can be heated by the sun, and tile-covered or stone interior walls or floors to "soak up the sun."

Because of the increase in window size, double or triple layers of glass ("glazing") often are used to lessen heat loss. Coated "low-e," or low-emissive, glass also helps keep heat from escaping through windows, and the gap between the multiple glazing layers can be filled with an inert, colorless gas like argon, which creates an additional heat barrier. Because daylighting reduces the use of electrical lighting, and the heat it produces, the need for cooling is reduced, too, so air conditioning systems can be smaller, saving energy again and again every summer.

Solar Thermal

The sun can heat both water and air, which in schools can offset a significant portion of the energy used. Solar-heated water can be used directly to provide hot water for kitchens, restrooms, locker-room showers, or swimming pools, or can be run through other systems to provide space heating and cooling or to produce steam for various needs.

Although the most common use of solar energy systems is for domestic hot water needs, solar water heaters can provide many types of buildings with a large proportion of the hot water used, reducing energy costs. More than 200,000 commercial buildings, 1.5 million homes, and hundreds of thousands of indoor and outdoor pools get their water heated by the sun.

Solar energy also can be used to cool or air condition a school, replacing significant energy demand during hot spring and fall days in southern climates. See the Ferry Pass School in Florida [page 12] for an example.

Where It's Working

In the East...

High School Student Pushes Solar

"This is a Respect and Awareness Project"

My name is Scott Goldman and I've been working on a project to set up PV modules at my school.

I think the idea to try and set up a solar program at my school came to me near the beginning of the school year as I was sitting outside on the school patio. I looked around and realized it was incredibly bright outside. I figured out then that this was why I was always squinting during my afternoon classes. Because it was so bright outside, it seemed very dark inside. I realized that instead of hiding ourselves from the sun's light, we ought to take advantage of it. After that, the idea of setting up solar panels on the roof of my school became a project.

The first step I took was to look up solar in the Yellow Pages. The next and most successful step was to talk to my dad. My dad is an energy partner at the law firm of Skadden, Arps, Slate, Meagher, and Flom. One of his friends and clients is Jim Caldwell, a solar expert from the area. My father and I talked to Jim on the phone one Saturday and from there I've set up a list of contacts from California to Florida to Massachusetts (and many in D.C., also). If there is one thing that I've learned, education is your best ally in the solar industry. The more you study about solar energy and the constantly changing politics behind it, the more likely it is that people will listen to you and encourage you.

Contrary to what it might seem, this is not a science project. Although solar applications for schools are typically related to education, this project is related to awareness. Rather than a science project, I tend to think of this as a "respect and awareness" project.

The true goal of my project is to show students that the environment is not as abstract as it seems. I want to show people that the environment isn't just about pollution in a river that they've never heard of; the environment can be on our

(continued)

roof. Not only is "environmentalism" a misunderstood word, but the word energy at my school most commonly refers to how much coffee a student drinks the night before to study for a test. This is why the primary goal of the project was to set up an energy audit for the school and to get students to do simple things such as turning off lights to save money.

I would like to finish my project by installing one kilowatt of PV. Although one kilowatt of PV paneling would not have a significant generating impact, it would pave the way for future energy projects in my school and other schools in the area. Since my school is a private school, it is always looking to improve its image and appeal towards parents of prospective students. It is this striving for improvement that I believe will be the reason why the school will agree to install solar panels.

Other students are involved in my project through the Environmental Committee I head. The purpose of the committee is to bring people together who are interested in starting other projects like mine and provide experience to other students in conducting large-scale school projects. An article in the school newspaper about the project won it respect throughout the student body and faculty. The head of our science department, Bill George, has helped greatly by addressing the importance of the educational potential. Also, principal Paul Levy and vice principal Bill Young have helped by showing how the administration of the school works and how one goes about setting up meetings and proposals. Most important has been the help of school engineer George Buckwalter, who knows more about the school than anyone.

I would like other students interested in solar energy or energy conservation to know that there are people interested in what you have to say. If I've noticed anything, it is that students have the most powerful voice of all when it comes to projects of this kind. I urge all students interested in solar energy to not be intimidated by the size and sometimes complexity of the solar industry, and to pursue your goals according to what you think needs to be done.

— Scott Goldman, 16 years old, Sophomore Class
Georgetown Day High School, Washington, D.C.

Georgetown Day Principal Paul Levy says that "the school has made quite a commitment to Scott because we are very impressed with his effort." Levy sees the installation of solar panels on the high school roof as "highly probable." The roof on the 11-year-old building has a lifetime of 10 years, so the school will soon have to rebuild it. Goldman located a company that makes flat roofs out of one big solar panel. The principal has stated that it would be just as simple to install a solar roof as any other kind. As the school spends up to $200,000 on power each year, producing even 10 percent of their own power could translate into significant savings, and any money spent on solar panels would quickly be paid back in savings on electric bills.

Contact: Scott Goldman, via eMail at Sharky193@aol.com.

Students Elect Solar

Students at Mast Academy High School in Miami, Florida, have been given the opportunity to critically analyze and discuss the intimate relationships between energy, ecology, economy, and politics. For the second year, the school has offered an Honors elective science course called *Solar Energy and Alternatives*. Thirty students enrolled when the course was first offered in the 1996/1997 school year. The class grew more than 300 percent to more than 110 students—almost one-fifth of the entire school population—in 1997/1998.

The course offers a comprehensive study of energy, with a focus on solar and other renewable sources. The students learn hands-on through experiments in energy conservation, sustainability, insulation, passive and active water heating, domestic design, water purification, and solar cooking and food drying. Some of the equipment used for the experiments include solar cookers, a 30-gallon passive solar water heater, and solar electricity generators (PV modules, with battery storage).

Some of the highlights that have occurred in 1997 and are planned for 1998 are:

• **Days at the Zoo**. For the last two years, students have displayed their projects at the Miami-Dade Metro Zoo, explaining and sharing solar cooking with zoo visitors throughout the day.

• **Annual Solar Celebration**: The Sky is the Limit. In May, 1997, the first solar celebration was held for the entire school, with more than 200 people from the community, regional school administrators, parents, and solar company representatives attending. At the second Solar Celebration, to be held in May, 1998, students and teachers from other schools will be invited to share in the annual event.

• **Contemporary Issues in Science** (CIIS) was a forum held in March, 1998, to discuss energy and its ramifications on society, the environment, economy, and politics with energy professionals, community leaders, policy makers, and university professors.

Currently, the equipment and materials used are provided by the school, which is in need of sponsors. The school has submitted a grant application to the U.S. Environmental Protection Agency in the hopes of meeting some of the costs of the program materials. For their course work, students use newsletters and magazines, such as *Solar Today* from the American Solar Energy Society, for their research, and rely heavily on the Internet for the latest technology information.

This course also provides students with insight into career opportunities in alternative energy. The SolMates Foundation and Solar Energy International are partners and consultants for this program.

Contact: Roy Johannesen, The SolMates Foundation, 800.527.6527, or Ken Olson, Solar Energy International, 303.963.8855.

Solar's Grand Prize

High school students around the country are invited to design solar-powered devices (either original designs or improvements to existing devices) in a contest intended to inspire interest in scientific studies and possible careers in renewable energy. The design contest is sponsored by the Potomac Region Solar Energy Association.

The contest allows students to apply principles learned in physics and science classes to practical projects, and offers the opportunity to gain personal reward for their efforts. Teachers and schools also receive recognition, in the form of trophies and Solar Educator plaques, for sponsoring winning or multiple entries.

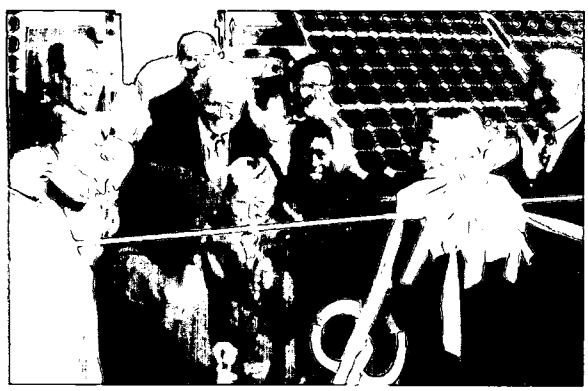
Designs are judged on conceptual understanding, originality, and presentation. Past competitions have included such innovative ideas as a solar-powered pager, a solar-powered walkman, a solar-powered hammock swing, and a utility-interactive solar system. Students compete for prizes totaling $1,500, ranging from $100 to a grand prize of $500. Entrants must demonstrate not only an understanding of solar technology but also how the design fulfills a human or environmental need.

The 4th Annual High School Student Design Contest, with entries due April 30, 1998, is coordinated by the Potomac Region Solar Energy Association, with support of the American Solar Energy Society, Solar Energy Industries Association, and the Utility PhotoVoltaic Group.

Contact: Potomac Region Solar Energy Association, 301.593.4752. Internet: www.solstice.crest.org/renewables/prsea.

Michigan Schools Get a Slice of the Sun

Detroit Edison, an electric utility in Michigan, launched its SolarCurrents program on Earth Day in 1996 with the opening of a solar electric power plant outside Ann Arbor. The utility expanded the program in 1997 with a second photovoltaic facility in Southfield, Michigan, and a new phase, called SolarSchools, to benefit schools in its service area. Commercial customers pay for new solar generation through SolarCurrents, and credit for the power goes to local schools.



Students in Michigan help mark the official start-up of Detroit Edison's second solar generating facility in Southfield, Michigan—the first system to contribute solar power to its SolarSchools Program.

Under SolarSchools, six commercial

customers will help Detroit Edison promote solar energy by becoming partners with 10 south-eastern Michigan school districts. Each participating school receives credit towards its electric bill, which is donated by its business partner, for 2,000 kilowatt-hours of electricity annually from the Southfield solar electric facility. Detroit Edison also has developed a two-week curriculum on solar and renewable energy for grades four through six as part of the SolarSchools program. The package meets 1998 national and state of Michigan educational objectives.

"We are pleased to offer this service because we know customers want Detroit Edison to provide energy alternatives like solar," says Gerard M. Anderson, Detroit Edison executive vice president. "Detroit Edison and its customers have become partners in exploring the potential for solar facilities in Michigan. We need the support customers have provided to make solar power a viable supplement to conventional power sources." Detroit Edison expects to build additional solar facilities in 1998.

Detroit Edison was selected to export the success of SolarSchools across state lines as the contractor for the Maryland Solar Schools Program [below].

Contact: Norm Stevens, Detroit Edison, 313.235.9462.

Maryland Promotes Solar Roofs for Schools

The Maryland Energy Administration selected Detroit Edison, an electric utility which already had a solar schools program in Michigan, to bring its experience and success to Maryland.

Begun as a direct response to the challenge issued by the President's Million Solar Roofs Initiative announced in June of 1997 [see page 2], the Maryland Solar Schools program was initially designed to take advantage of "green pricing," the willingness of a customer to pay more for power generated by renewable energy sources. The project seeks to place two-kilowatt solar photovoltaic systems on up to 10 Maryland schools.

Detroit Edison also will include a two-week curriculum package that is used in Michigan. The existence of a curriculum package is important in getting schools interested and selling them on the program.

"It is essential that we continue to look for ways to help our schools and provide new educational opportunities for our children," says Maryland Governor Parris N. Glendening. "This project provides those opportunities in addition to direct energy, environmental, and economic benefits."

Instead of green pricing, Detroit Edison will solicit commercial sponsors, a feature of its program successfully implemented in Michigan. In the next two years, the MEA will assist Detroit Edison in selecting 10 elementary schools and sponsors for the program.

The contract funding from MEA is intended to be used to buy-down the cost of the photovoltaic systems and, when added to corporate sponsorship, allows schools to participate virtually free of charge. Detroit Edison will supply the monitoring equipment for the students to analyze energy output from the system. Each school will, however, be responsible for liability and maintenance.

Although MEA has targeted elementary schools, all public and private schools up to college level are eligible. If the Schools Program meets its ultimate potential, with a similar system on every school building in Maryland, three megawatts of electricity—enough to completely power more than 1,000 houses—would be produced by the sun. The MEA hopes to continue to expand the program with additional installations in the future.

Contact: Chris Cook, assistant director of policy and planning at the Maryland Energy Administration, 410.974.8444.

Pop-Up Solar Classrooms

Imagine a portable classroom—capable of providing temporary student overflow space or disaster relief—powered by the sun. In 1997, the *New York Times* reported on a prototype of exactly that. Commissioned by the New York City School Construction Authority, the firm of FTL Happold was asked to create an alternative to the type of trailers currently used by schools which run out of space but are unable to commit to new, permanent construction.

The prototype, expected the summer of 1998, features a trailer which can be delivered by a truck. It is expanded hydraulically to house two classrooms and up to 70 students, and take up 1,500 square feet. All of the classrooms' electricity will be provided by solar panels on the roof, while a "plug-in" diesel generator powers the heating.

Contact: Todd Dalland, FTL Happold, Manhattan, New York, 212.732.4691.

Florida Students Study Energy and the Environment

In Florida, a year spent learning about environmental issues under a program called ECO-TREK is topped off with a day-long summit. The topic for the 1998 Brevard County Youth Environmental Summit is "Managing Energy Impacts on the Environment," with subject areas on transportation, buildings, and natural systems, which includes renewable energy. The program is open to Brevard County schools, for kids in the 6th through 9th grades, and involves students developing research and action projects throughout the year which then are shared with other students at the main event on April 30, 1998.

Ideally, the summit will be coordinated by a different organization each year, with varying topics, but always with an environmental focus. The 1998 summit is being coordinated by the Florida Solar Energy Center. The entire budget, $20,000 for 1998, is covered by community donations, so there is no cost to participating students and teachers.

ECO-TREK is a way for students to learn about their local environment and how humans affect it. The program includes a teacher workshop, interactive energy and environmental exhibits, a facility tour, and solar and other renewable energy demonstrations by researchers and scientists. At the summit, participating students use their projects as a basis to formulate a "vision for the future" and share those visions at the day-long event, providing students an opportunity for in-depth interaction with community members and other students.

The program expanded to 210 students in 1998, coming from 15 public middle and junior high schools and five private schools, and has more than doubled the number of exhibitors to 55. The 1997 summit, on pollution and waste, was attended by 168 students from 14 schools, and included exhibits from 20 local groups and businesses.

Contact: Susan Schleith, Energy Education Coordinator, Florida Solar Energy Center, 407.638.1017.

Solar Cools, Warms, and Lights Florida School at a Savings

The Ferry Pass Middle School in Pensacola, Florida, is a showcase of solar thermal, solar electric, and passive solar technologies at work. The solar energy systems at Ferry Pass collectively represent the first demonstration of an ambitious energy service and education program called Solar For Schools. It is administered by the SolMates Foundation, headed by former University of Florida professor Roy Johannesen.

The solar installations made in 1995 and 1996 produce energy savings for the school, as well as improving the learning environment and contributing educational opportunities for students.

The largest and most ambitious solar installation at Ferry Pass is a solar-heated "desiccant" air conditioning system which supplies conditioned fresh air to an 8,000 square foot science wing at the school. It is instrumented with temperature, pressure, and flow gauges and serves as a working educational lab for science curriculum. The air

Members of the SolMates solar energy summer school class at Ferry Pass pose by the school's mobile solar power generator.

15

conditioner operates with a high-efficiency electric heat pump to either cool/dehumidify or heat/humidify incoming fresh air, depending on the season. The heat pump uses a deeply buried pipe which loops water underground to pre-cool (or pre-heat) incoming fresh air. The desiccant unit regenerates from heat from two sources—waste heat from the electric heat pump and solar heat. In the cooling mode, this heat is used to dry a rotating desiccant wheel which, in turn, absorbs moisture from the incoming fresh air. Solar heat is collected from 640 square feet of solar thermal panels.

Ferry Pass also uses solar photovoltaic electricity. A mobile sun-powered generator supplies electric power for air conditioning and heating a classroom. During an emergency, it can be towed to any location in the school system to provide up to four kilowatts of solar electricity. Photovoltaic cells also supply electricity to a newly installed set of lights around the running track and power a security feature where motion sensors turn on the track lights after school hours. Photovoltaic electricity at Ferry Pass Middle School is also used to power an air conditioning energy recovery system in a science wing. This recovery approach recaptures cooling or heating energy that would normally be exhausted from the building. It uses direct current output from the PV panel and subsequently is among the simplest and most cost-effective photovoltaic cooling technologies.

Passive solar design is used to naturally heat, cool, and light part of the school. Several modular classrooms are outfitted with advanced solar daylighting systems which make use of a special window coating to decrease heat loss and diffuse light. These specially fitted windows then deliver high-quality nonglare light to the classrooms while electronic controls automatically dim electric lights in response to available sunlight. At full sun, this daylighting system reduces lighting energy consumption by up to 70 percent when compared to the conventional light fixtures they replaced. Also, highly reflective paint is applied to several modular buildings as well as to the main science wing. This simple, yet effective, upgrade was carried out with volunteer adult and student labor and has an added benefit of upgrading the appearance of the buildings.

Ferry Pass also has a solar-heated greenhouse,"energy" gardens where plants that produce burnable oil are grown, and a solar-heated aquaculture system (to raise edible fish) which features an advanced water purification system. These educate students about energy flows within a working biosystem.

The Solar for Schools project at Ferry Pass received financial support from the Florida Energy Office, University of Florida, Gulf Power Company, and the Pensacola community.

Contact: Roy Johannesen, The SolMates Foundation, 800.527.6527.

Roy Johannesen, director of The SolMates Foundation, and a Ferry Pass student check the gauges on the solar hot water system, which helps run air conditioning at the Florida school.

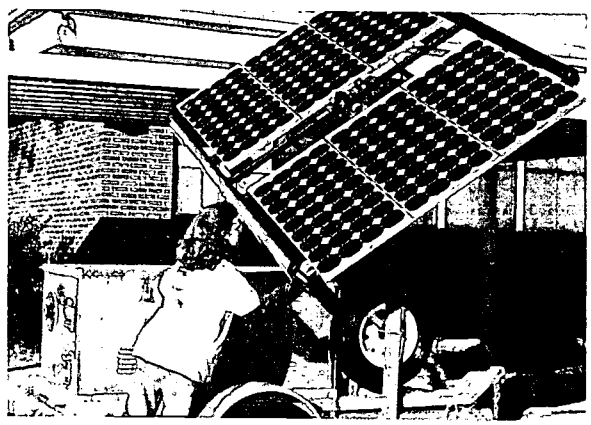
"I feel lucky to be in the Solar For Schools program. Hopefully, the program will get bigger, more advancing, and people from all around the world will come to be a part of the Solar For Schools program."

– Atwaul Lorelia Bennett, Age 13
Ferry Pass Middle School

Solar Studies at Ferry Pass

Solar energy education is a vital part of the Solar for Schools program. At Ferry Pass Middle School, two Solar for Schools educational exercises have proved to be very successful.

Science classes use CD-ROM learning tools offering self-contained courses on solar, complete with exercises and self-scored tests. The CD-ROM "The Sun's Joules," developed by the Center for Renewable Energy and Sustainable Technology, is an example of such a program. The second is a unique but highly replicable solar energy summer school. The four-week program was offered as a regular summer school class, but all the participants came as volunteers, prepared to conduct field work. In addition to learning solar energy basics, scientific methods, data taking, and measurement techniques, the students gained computer and public speaking skills, performed community service, and polished teamwork and leadership skills.



A Florida student moves in for a better view of the mobile solar generator at Ferry Pass Middle School.

In addition, a solar curriculum produced as a basic primer is available through the SolMates Foundation. It contains instructional material with hands-on lessons that use low-cost, readily available materials.

To obtain these instructional materials, send an eMail to RJOHANN710@aol.com or call 800.527.6527. Resources available through the Foundation may also be accessed through its Website at www.solmates.org.

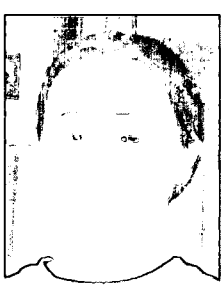
Solar For Schools Can Lower Electric Rates

The Solar For Schools program at the Ferry Pass Middle School in Pensacola, Florida, was launched as a vehicle for electric utilities in Florida to provide customer-supported solar energy services and, at the same time, lower electric rates. It grew out of a 1994 Florida Public Utility Commission recommendation encouraging utilities to sponsor "green pricing" programs, where customers donate money to help pay for solar and other renewable energy installations.

Solar For Schools was designed as a cost-effective energy management tool for an electric utility. Using solar energy during times when air conditioning loads force the utility to use costly "peaking power" can save a utility significant money and help keep rates lower.

Most of the funding for installing the solar systems and providing educational materials comes from utility customers through voluntary donations collected through their monthly bills. Two surveys conducted in the 1990s in Florida on the Solar For Schools concept revealed that the average, informed Florida electric utility customer would give $17 a year (1991 study) or $21 a year (1994 study). That translates to a potential of more than one hundred million dollars per year in donations to install solar energy systems in public schools in Florida alone.

Solar for Schools founder Roy Johannesen is confident that the program can function very successfully as a utility-supported operation. "Solar for Schools allows utilities to manage their entry into emerging renewable energy markets while keeping electric rates low," says Johannesen. "It also provides positive name recognition and greatly enhances the sponsoring utility's image. I consider it only a matter of time before major utilities realize that Solar for Schools can be implemented with minimal risk and cost in order to improve their bottom line."



"I feel important being a SolMate. It's really cool. Solar energy will be what we are going to use in the future and it's important for kids to learn about it so we can get ahead."

– Laura Marshall, Age 13
Ferry Pass Middle School

"The SolMates summer program taught me to get along, to be a part of something important."

– Benjamin Brown, Age 13
Ferry Pass Middle School

Students Want Solar Now

Students in the state of Massachusetts had a little something extra to look forward to in their science classes in 1997—solar electricity. Three schools in Massachusetts—two junior highs and one high school (Pickering Junior High, McCarthy Middle School, and Pentucket Regional High School)—were chosen to host photovoltaic systems as part of an innovative program to combine learning opportunities for both local students and the electric utility, New England Electric Service (NEES). Students learn about one of the important energy sources of the future, while the utility monitors system performance to test the feasibility of using PV in its energy mix.

U.S. Senator Edward Kennedy (a Democrat from Massachusetts) praised this innovative use of solar power. "This new solar facility will be an outstanding hands-on tool for students to learn about renewable energy and its benefits to the environment," said Kennedy of the awards made at Pentucket and Pickering. "I commend the students and staff of Pentucket Regional High School and Pickering Junior High for putting together a winning application. And I congratulate the Solar Now program for making such a significant difference in communities across Massachusetts and the nation."

The comprehensive educational program is called "Solar Solutions for Schools." It was conceived and is administered by Solar Now, an international nonprofit agency dedicated to education in the field of alternative and renewable energy, with an emphasis on photovoltaics. It is located at Beverly High School in Massachusetts, the site of a 100-kilowatt solar photovoltaic system installed almost two decades ago. Left in disrepair for several years, the system was recently refurbished and is now used as an on-site educational tool for both students and teachers.

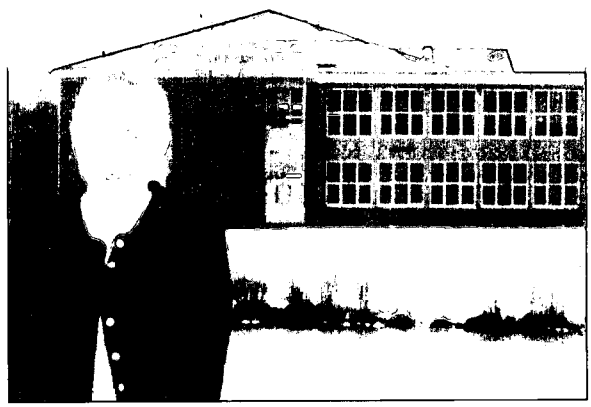
As a national center for training, Solar Now and its staff facilitate workshops for teachers, compile curriculum resources (pre-K through undergraduate college level), provide hands-on tools for students, offer college summer internship programs, and provide regional

coordination of the Junior Solar Sprint competition [see page 37].

In fact, the solar system and information from Solar Now inspired local high school student Laura Walters, who was researching a science project on solar power, to convince her own Pentucket High School to apply for the grant to receive the solar system. Her enthusiasm, and that of her science teacher, Don DeFelice, is credited in part for the selection of Pentucket.

Pickering Junior High (in Lynn) and Pentucket Regional High School (West Newbury), received four-kilowatt roof-mounted PV systems, and McCarthy Middle School (Chelmsford) received a two-kilowatt system. Electricity generated by the PV is not used directly by the schools, but feeds into Massachusetts Electric's power grid.

In addition to the hardware, Solar Now has helped the schools prepare curriculum for its students and take advantage of the learning opportunity of the on-site system. "There is already a great deal of material out there," said Carmel Valianti-Smith, director of Solar Now. "In some cases, it's just a matter of pulling it all together and making it accessible for the teachers."



Pentucket High School student Laura Walters shows off a solar system installed with the help of Solar Now and Massachusetts Electric.

Schools in the U.S. states of Hawaii and Wisconsin are participating in programs similar to that offered the schools in Massachusetts. They are sponsored by their local utilities, Hawaiian Electric (HECO) and Wisconsin Public Service (WPS). In fact, three teachers from different school districts in Wisconsin recently visited Solar Now for a week-long seminar to learn more about how to incorporate PV systems at their schools into the curriculum. One of the criteria for schools selected for the Massachusetts program is that they have Internet access. Solar Now hopes to help those schools utilize the Internet to communicate with other school PV programs across the country, including those in Wisconsin and Hawaii.

Solar Now is an excellent resource for schools, students, and teachers with an interest in solar energy but without a clear idea about how to incorporate its education into their existing curriculum. More information on the specific programs offered by Solar Now can be found on the Internet at www.eren.doe.gov/solarnow.

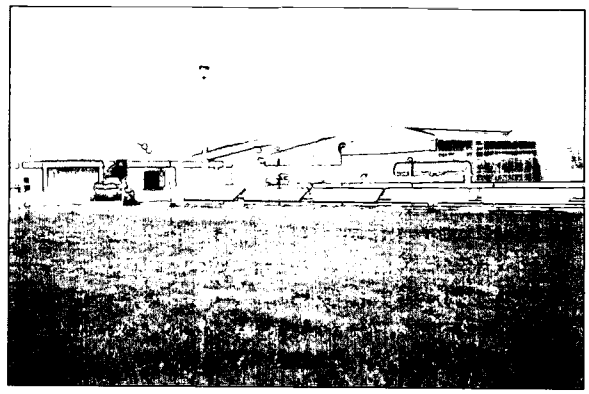
Contact: Carmel Valianti-Smith, 508.927.9SUN.

Florida Lawmakers Push Hot Water

A solar water heating system was installed at Christa McAuliffe Middle School in Boynton Beach, Florida, when it was constructed in 1987. The solar system provides hot water for both the school's cafeteria and locker rooms.

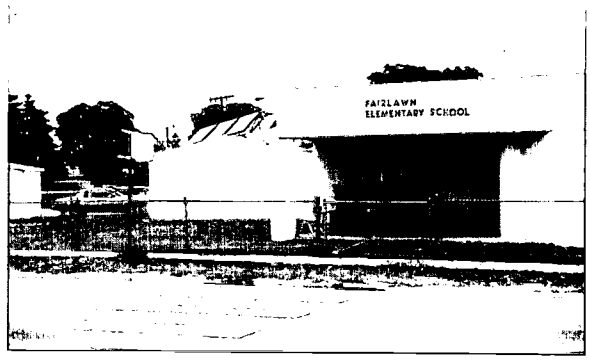
Palm Beach County installed the solar thermal system on the 1,160-student school in response to a 1982 law passed by the Florida Legislature mandating that newly constructed schools—or additions to schools—which estimate that their hot water usage will be more than 1,000 gallons a day consider using solar heating systems.

The flat solar collectors cover 720 square feet and, rather atypically, sit on the ground instead of the school's roof. When temperatures drop, hot water is circulated through the collectors to protect them from freezing. Water which has been heated by the solar collectors is stored in a 1,500-gallon storage tank.



A solar water heating system at the Christa McAuliffe Middle School in Palm Beach County, Florida, provides hot water for locker rooms and the kitchen.

The Olympia Heights Elementary School in Dade County, Florida, uses water heated by the sun in its kitchen.



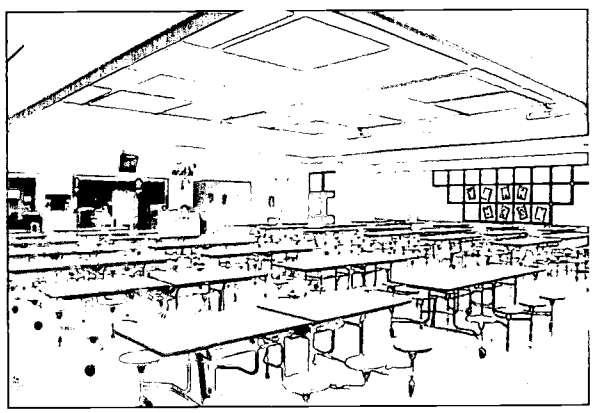
The kitchen in Fairlawn Elementary School in Dade County, Florida, gets its hot water from its solar water heating system.

Schools—and Students—Brighten in North Carolina

Students at Durant Middle School in Raleigh may not realize their new school is saving $165,00 a year in energy costs, but they *have* noticed that their grades are better! Schools incorporating passive solar features—like Durant and six other new schools in Wake and Johnston Counties in North Carolina that use daylighting—not only use less energy, but student grades have improved and attendance is higher. Studies have shown that natural lighting has a positive effect on student attitudes and performance. Test comparisons have proved that students attending daylit schools for two or more years out-perform students in nondaylit schools by 14 percent.

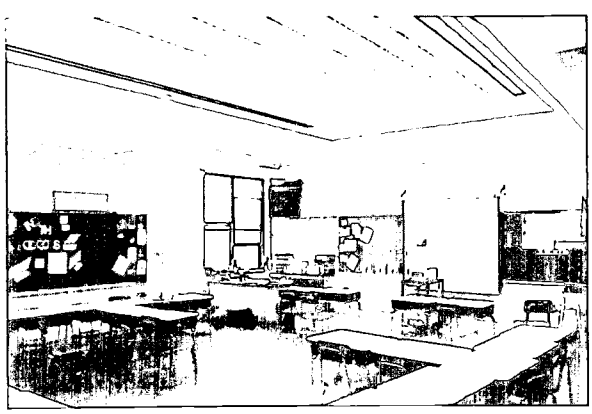
Natural daylighting is featured in all major occupied spaces within Durant Middle School, including classrooms, the cafeteria, and the gymnasium. The school was oriented on an east-west axis, and north- and south-facing monitors on the roof funnel the light inside through a series of baffles which diffuse the light evenly throughout the middle of room. Classroom windows on the north and south walls use "low-e" glazing to prevent heat loss.

Automatic dimming controls on electric lights allow their use only when daylight is insufficient; two-thirds of the time sunlight provides lighting levels superior to what is required. Additional savings accrue due to occupancy sensors, which detect motion and automatically turn lights off if no one is in the room.



Daylit schools are less expensive to operate, use less energy, and are more comfortable than their electrically lit counterparts. Daylighting not only provides a better quality of light, there is evidence it improves productivity. Durant Middle School in Raleigh, North Carolina, which uses daylighting, achieved the highest attendance rating of more than 100 schools in Wake County.

Because electric lights also give off heat, using them less reduces the amount of air conditioning needed during the warmer months (students attend Durant throughout the year, including the summer). At Durant, daylighting—combined with a radiant barrier on the roof that reflects the sun's heat and few east and west windows to reduce heat gain from early morning and late afternoon sunlight—lessens the cooling load to about 70 percent of that of a conventional school.



Ecology needn't take a backseat to budget. Voted by the American Institute of Architects in 1997 as one of the top ten most environmentally friendly buildings in the U.S.,

Durant Middle School came in $700,000 under budget. Decreasing the size of the cooling and electrical systems saved $115,000 in construction costs, while the reduction in total energy use will save $165,000 per year. The school paid for all of its daylighting features from energy savings within the first six months of operation. And increased performance and fewer sick days for both students and staff mean even greater savings.

Daylighting integrated with other energy-efficiency measures have made Durant Middle School an excellent example of what architects can do to design better school buildings. As architect Gary Bailey points out, "We've created a healthier learning environment that uses a lot less energy and costs about the same to build." Architects in most climates can achieve similar results. School boards, administrators, teachers, parents, and students should insist on it!

Contact: Gary Bailey, Innovative Design, Raleigh, N.C., 919.832.6303.

Vermont Community Chooses Daylighting

Overcrowding in Union 32 Junior/Senior High School in Montpelier, Vermont, led to community action to build the needed classroom space. More than 300 volunteers—many with no children in the school system—supplied most of the labor to construct two new classrooms. The short time-frame (May to August, 1996), the mix of skilled and unskilled labor, and financial constraints resulted in a simple design and use of traditional construction techniques. Natural daylighting, good ventilation, energy efficiency, a positive learning environment for students and staff, as well as low cost, were the main design goals.

The orientation of the addition, perpendicular to the main school building, left a long side facing southeast, making good use of daylighting through mid-afternoon, which matches school hours. Sunlight streams through a row of fixed clerestory windows along the top of the southeast wall, hitting a light shelf and bouncing diffused daylight into the interior. Sealed, double-glazed, "low-e" window units were framed on-site for the clerestories, which was much cheaper than purchasing manufactured windows with fixed panes.

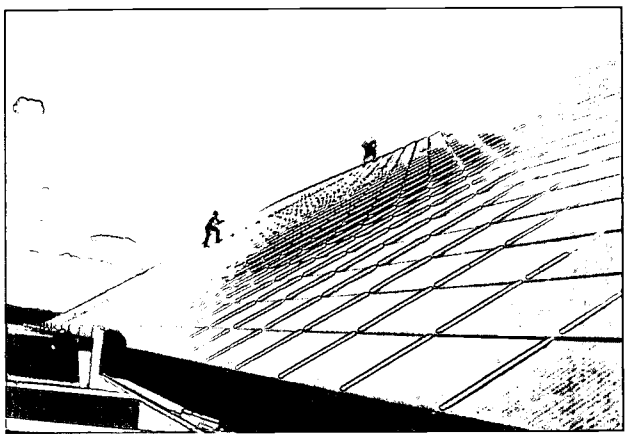
High-efficiency fluorescent lights which automatically dim provide adequate lighting under all sun conditions while saving energy. The southeast-facing windows provide some passive solar heating of the room.

This project not only built an energy-efficient, daylit school addition, it also built community!

Contact: Andrew Shapiro, Energy Balance, Inc., Montpelier, Vt., 802.229.5676.

Georgetown University

The Georgetown University solar system was built to test the use of large-scale, building-integrated photovoltaics on commercial buildings. With funding from the U.S. Department of Energy and PV modules from Solarex Corporation, Georgetown, in Washington, D.C., showcases what many consider the future of solar energy systems.

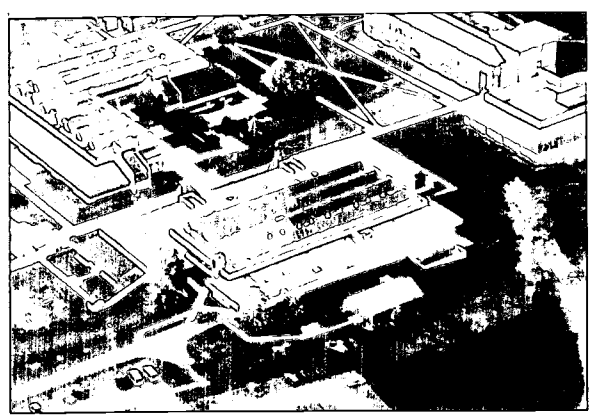


The array is not simply placed on top of the building but incorporated into the building itself, actually displacing the use of some building materials, creating a more aesthetically pleasing appearance in addition to providing up to 50 percent of the building's power needs. The 337-kilowatt array is built into the steeply slanted roof of the University's Intercultural Center.

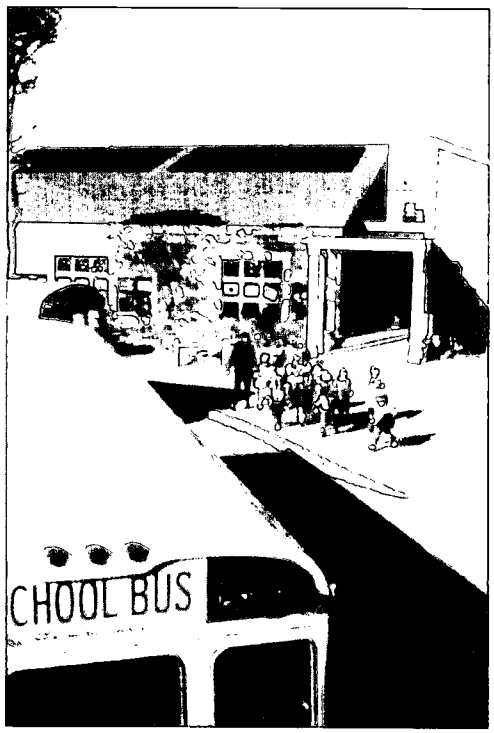
Contact: Sarah Howell, Solarex Corporation, 301.698.4272.

Solar Roof on Maryland College

The Maryland Energy Administration cosponsored a solar energy system installation at the Montgomery Community College in Germantown, Maryland, in October 1997. The 24.5 kilowatts of power produced from the system atop the roof of the Science and Applied Studies building are fed directly to the local utility, Potomac Electric Power Company. The system was installed by Solarex Corporation, under its PV-VALUE program, with cost-sharing provided by the U.S. Department of Energy.



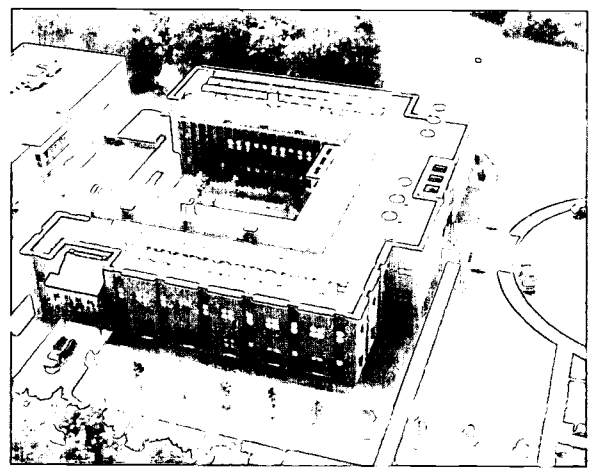
Sun-Powered Schools off Massachusetts Coast...



A four-kilowatt rooftop PV system supplies power to this elementary school in Nantucket, Mass.

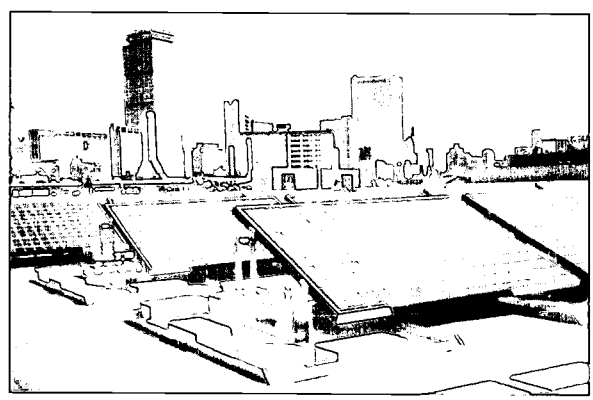
...At a New Jersey College...

An 18-kilowatt rooftop PV system was installed by Atlantic Electric at the Richard Stockton College in Pomona, New Jersey.



...And Along the Boston Skyline

A research project funded by the U.S. Environmental Protection Agency, the Electric Power Research Institute, and eleven utilities is studying the impact of clean technologies like solar in improving air quality, reducing peak electric demand, lowering energy costs, and reducing the need for new power plants.



This EPA-EPRI 18-kilowatt system was installed at Northeastern University to power the Ell Student Center on the Boston Campus, with the help of the local utility Boston Edison.

Solar Lights Teach Children the Value of PV

For the last two years, students at Martin Middle School in Taunton, Massachusetts, have been getting first-hand experience in the value of photovoltaic lighting.

Through the city's Photovoltaic Light Demonstration Project, a PV array charges a bank of batteries during the day to provide light to a parking lot in the rear of the school where students are picked up from the school's Head Start program.

The PV system is credited with providing added safety for students and parents as well as increasing security in the rear of the school. The PV demonstration was developed because it wasn't practical to run a line extension into the parking lot.

"The PV streetlight is cost-effective compared to any other options the school had and it provides a hands-on project for the school's science students," explains Timothy J. Hebert, planning engineer for Taunton Municipal Lighting Plant. Students at the school are taking daily readings from the light's hour and voltage meters, and TMLP is teaching students about the operation and benefits of photovoltaic energy systems.

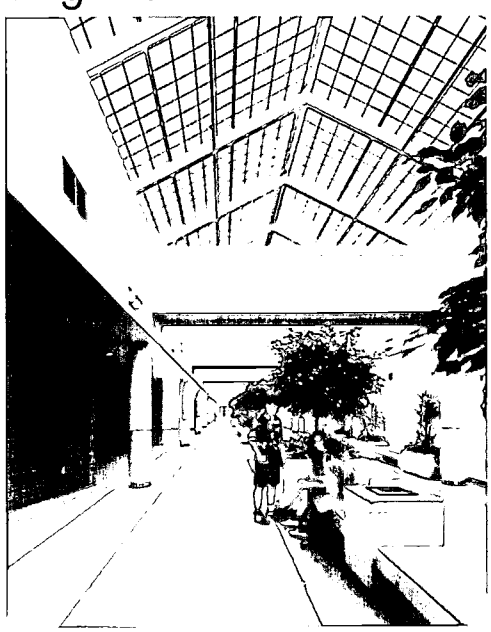
The system has two 245-Watt PV modules charging six 12-Volt batteries. The battery bank can provide two to three days of backup power to the 50-Watt high-pressure sodium lamp, depending on the weather.

As a member of the Massachusetts "PV for Utilities" Working Group, Taunton Municipal Lighting Plant is providing the PV-powered lighting system by participating in a cost-sharing program with Sandia National Laboratories and the project manager, Ascension Technology of Waltham, Massachusetts. Sandia provided $15,000 for equipment procurement, Ascension designed the system and procured equipment, and TMLP provided the pole, crossarms, and bracing, and a line crew to assemble the system and install it on the pole.

Hebert said the project has been a very cost-effective way for TMLP to gain actual experience with PV performance and to further study applications where a renewable resource can be cost-competitive with traditional line extensions.

Contact: Timothy Hebert, Taunton Municipal Lighting Plant, 508.824.5844. eMail: tmlp@tmlp.com. Internet: www.tmlp.com.

Daylight Shines in Virginia



Architects Mills, Oliver & Webb designed the building that uses daylight to illuminate hallways at Sherando High School in Frederick County, Virginia.

New York Utility Installing Solar PV on Six Schools

The Manhattan-based New York Power Authority is installing solar photovoltaic systems on six schools in the greater New York City area during the summer of 1998, including four on Long Island (in the towns of Bohemia, Port Jefferson Station, North Babylon, and Brentwood) and two in suburbs on the north side of the city (White Plains and Valhalla). The solar systems should be in place within weeks of the students' return to school in September 1998.

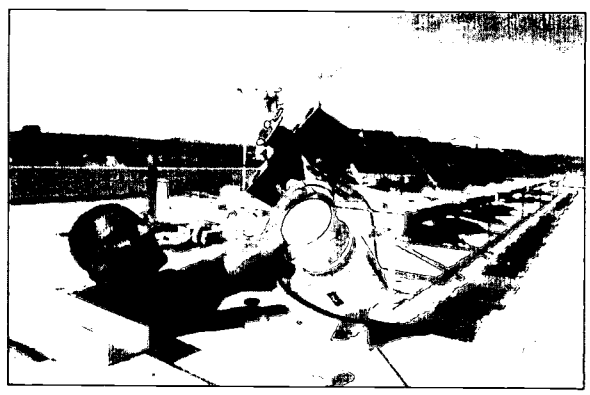
Each system will produce six kilowatts of electricity, displacing electricity normally supplied the school from utility lines. NYPA is providing the solar power under a solar commercialization program managed by Sacramento, California, Municipal Utility District as part of the UPVG's *TEAM-UP* program.

Sunny climes don't have the corner on viable solar use. High conventional electricity costs help make New York a leading state for increased use of solar power. In Valhalla, New York, a 36-kW solar electric system helps provide power for Valhalla College's Laboratory and Research Building in Westchester County. And a rooftop PV system provides four kilowatts of power for White Plains, N.Y., High School. New York Power Authority completed both installations in early 1996.

Contact: Lumas Kendrick, New York Power Authority, 212.468.6793.

Solar at Virginia Universities

Virginia Tech, Blacksburg, Virginia.



This 2-kW solar system at the Virginia Tech Solar Test Facility in Blacksburg, Virginia, serves research and educational needs by providing data on solar energy conversion. Here a student adjusts a device which measures the amount of sunlight hitting the solar panels. Comparing the amount of solar energy available with the amount of energy produced by the system helps in determining system efficiency and detecting problems.

***University of Virginia (UVA)**, School of Engineering and Applied Science, Charlottesville, Virginia.* As part of a three-year project in conjunction with Solarex Corporation, UVA is conducting research that focuses on development of improved materials. The goal is to develop new tools and techniques to improve the manufacturing process—tools that can be incorporated into Solarex's present and future PV manufacturing plants. Solarex

plans to install a 50-kilowatt solar system on the UVA School of Architecture as a laboratory for energy efficiency and renewable energy design and applications.

Contact: P. Paxton Marshall, UVA, 804.924.3164. eMail: marshall@virginia.edu.

James Madison University (JMU), Harrisonburg, Virginia. The Program of Integrated Science and Technology at JMU offers an energy curriculum that includes courses in materials properties, renewable energy technologies, and economic, business, and policy issues associated with renewables. The school plans to install several solar thermal collector systems on top of the new $18 million state of the art science and technology facility to support the course. A proposal is also in development to design and construct a solar-powered absorption-cooling system with ice storage to provide chilled water to the new facility to be built on campus starting in 1998.

Contact: Jonathan Miles, Assistant Professor, JMU, 540.568.3044.

In the Central States...

School Kids Can Change the Way We Use Energy

In West Branch, Iowa, science teacher Hector Ibarra and his sixth grade students regularly go beyond the four walls of their classroom when they study energy. In doing so, they become agents of change in their community, showing adults how to use energy-efficient lights, cut water use, and make use of solar power.

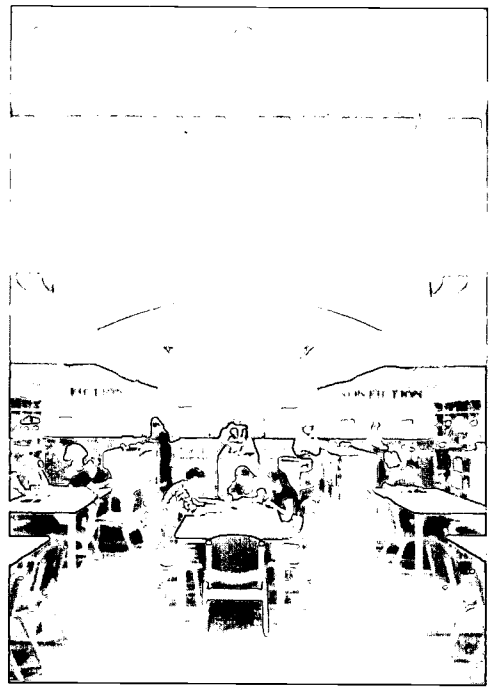
A few years ago, one of Ibarra's classes measured the energy use of the lights in the middle school. They discovered that the flourescent tubes could be replaced with compact flourescents that delivered the same quality of light but were 67 percent more efficient. They took their findings to the school administration and school board, and then to some local businesses. The senior vice president of the local bank was impressed enough with the students' conclusions that he arranged a low-interest loan to the school to finance a conversion. Six months later, the school board finally agreed to go ahead with the sixth graders' plan, and the retrofitting took place in 1995.

The conversion saves the school $240 a month, which covers the loan. The note will be paid off in 1999, while the new lights will provide many more years of low-cost service, at an energy savings of approximately 25,000 kilowatt-hours a year. The students helped retrofit an elementary school in 1997 and, in 1998, are working on a proposal to retrofit the town's high school.

The local bank applied the student's recommendations to its building as well, and students introduced the energy-saving lights to 150 West Branch homes.

The West Branch students also have reduced water usage in the school and in their homes by installing faucet aerators and low-flow showerheads; planted thousands of trees; and designed, built, and raced miniature solar photovoltaic-powered cars in teamwork with their parents. The projects receive funding and assistance from the Iowa Energy Center; the Iowa Science Foundation; local utilities such as Linn County Rural Electric Cooperative, Iowa Electric, and US WEST; and many other sources. Ibarra says a key to the success of his students' projects has been parental and community involvement, and partnerships with businesses to give the projects longer life.

"The best way to minimize environmental and financial waste is by not creating it," says Ibarra, winner of a Presidential Award for Excellence in Science and Mathematics. "Our students and schools can be leaders in promoting water and energy efficiency."



The "climate-responsive" Franklin High School in El Paso, Texas, contains sustainable design features such as an efficient heating and cooling system with "smart" controls, passive solar shading, natural ventilation, increased roof insulation, and a water conservation system that collects rainwater.

For more information, contact: Hector Ibarra, West Branch Middle School Science Classes, P.O. Box 637, West Branch, IA 52358.

Central & South West Installing Solar PV on 19 Schools

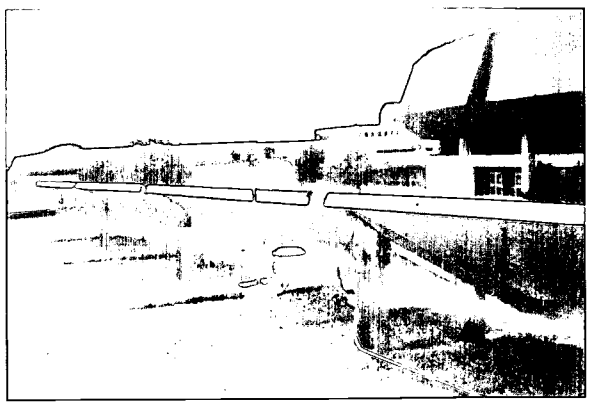
In February of 1998, Central and South West, a utility holding company headquartered in Dallas, Texas, announced plans to install 19 four-kilowatt rooftop photovoltaic systems at selected public schools throughout the service territories of three of its distribution companies in Texas, Louisiana, and Arkansas. Solar systems will be installed at seven schools in the southeastern Texas area served by Central Power and Light, at seven schools in the Southwestern Electric Power Company area in northwest Louisiana and east Texas, and at five schools within the West Texas Utilities service territory.

Planergy, an energy services company based in Austin, Texas, was awarded the contract to handle the actual installation of the systems, complete with financing and maintenance. Planergy will also develop educational kiosks showing students real-time data, such

as the number of classrooms the sun is powering each day, and interactive websites to provide additional learning opportunities.

"This project not only provides the participating schools with clean electricity, it gives the kids a chance to see solar technology in action," says John Hoffner, director of advanced technologies at Planergy. "Planergy is pleased to implement this forward-thinking project."

Installation of the first system is expected to occur in September, 1998, with all systems installed and operational by February, 1999.



In 1997, Central and South West installed a two-kilowatt PV system on the roof of the university library on the campus of Abilene Christian University in Abilene, Texas.

Contact: Connie True, Central and South West, 214.777.1168.

'Green' School Uses PV Power in Minnesota

The Battlecreek Elementary Magnet School of St. Paul, Minnesota, generates a good portion of its electricity from a rooftop photovoltaic system. The 11-kilowatt solar power installation is a highlight of the school's commitment to environmental study. The PV system was installed in 1994 with a grant from the state of Minnesota.

Solar Lights at the Ball Park

Students at the Illinois Institute of Technology are installing solar photovoltaic-powered lighting for a billboard outside the Chicago White Sox's Comiskey Park on the south side of Chicago. Designed by a team of engineering students from the university, the demonstration project is a cooperative venture with Solarex, which donated panels that produce 2.2 kilowatts of power, and with Commonwealth Edison, Chicago's electric utility, which gave $16,500 to cover construction costs.

Initially, power produced by day will be stored in batteries for nighttime lighting. In a second stage of the project, the students will add a small hydrogen-powered fuel cell to make electricity; the solar panels will then power the electrolyser that generates the hydrogen fuel.

Contact: Professor Henry Linden, Illinois Institute of Technology, 312.567.3095.

Safe Crossing with Solar Energy

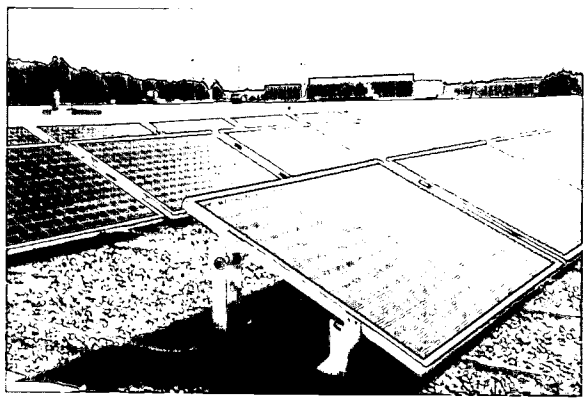
Houston Independent School District is installing 1,200 solar school zone crossing lights at more than 200 elementary schools across the city. Solar power was chosen because it has proven to be reliable and cost-effective in small, stand-alone applications. The solar systems not only offer immediate payback over installation of conventional power lines to the lights, they also feature battery backup in the event of bad weather. Another benefit is that, once installed, there are virtually no operating and maintenance costs. Publicity about the project has prompted dozens of other Texas school districts to evaluate similar systems for their schools.

Wisconsin Schools Get Solar Wise

In late September of 1997, Wisconsin Public Service Corporation of Green Bay, Wisconsin, selected three area high schools from 28 applicants as the latest sites for solar electric installations through its SolarWise for Schools program. Rooftop photovoltaic systems producing approximately four kilowatts of electricity each will be sited at Waupaca, East De Pere, and Mosinee high schools. Three other high schools had been selected for 12-kilowatt solar installations in 1996: Antigo High School, Southern Door High School, and Green Bay East High School.

Two students display their projects at the "Solar Olympics" held at the campus of the University of Wisconsin-Green Bay.

"It's a good way for students and teachers to get hands-on experience with a renewable energy source," says Chip Bircher, manager of the SolarWise for Schools program. "It's a great project that brings together utility customers, renewable energy advocates, science teachers, and students. With continued donations from our customers, we look forward to installing several systems each school year."



Southern Door School in Brussels, Wisconsin, hosts a 12-kW solar system on its roof. Students learn firsthand how solar works with the system installed by the local utility, Wisconsin Public Service.

In addition to the solar systems, seven other high schools were selected to receive

SolarWise for Schools curricula to be used in classroom study of renewable resources. The SolarWise curriculum is developed in part through a grant from the Wisconsin Environmental Education Board.

All 13 high schools will be included in the second WPS "Solar Olympics" competition held in early May, 1998, at the campus of the University of Wisconsin-Green Bay.

SolarWise for Schools is supported by voluntary donations from more than 2,700 WPS customers. The program also receives U.S. Department of Energy funding through UPVG's *TEAM-UP* solar commercialization program. Ascension Technology of Waltham, Massachusetts, is a partner with WPS in its *TEAM-UP* project. SolarWise for Schools customer contributions are tax-deductible through the WPS Community Foundation.

Contact: Chip Bircher, WPS, 920.433.5518.

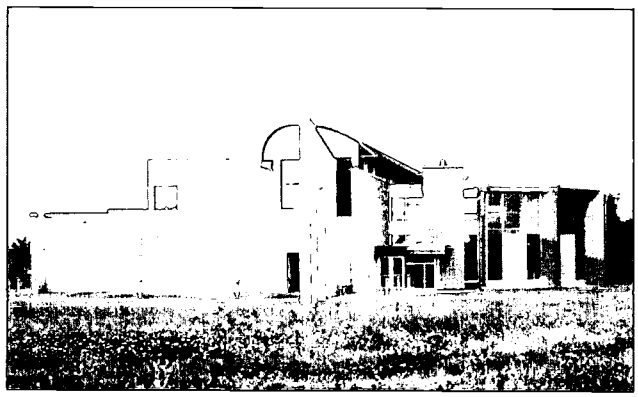
Two solar school programs have been chosen to receive 1997 National Renewable Energy Recognition Awards from the Interstate Renewable Energy Council. SolarWise for Schools in Wisconsin [left] and Solar Solutions for Schools in Massachusetts [page 16] will receive the awards, given to recognize innovative renewable energy programs in schools, state governments, U.S. Territories, the District of Columbia, and local units of governments.

Northern Iowa Builds and Educates

The Center for Energy and Environmental Education, which houses classrooms and research facilities at the University of Northern Iowa in Cedar Falls, uses daylighting and passive solar heating to save energy and money while teaching students energy and environmental concepts.

The long, narrow building runs east-west to maximize sunlight coming inside. Light through upper "clerestory" windows, high along the length of the southern side, bounces off a "light shelf" toward the ceiling, improving lighting uniformity and reducing glare. Daylight from the large, south-facing windows also warms a two-story high wall made of limestone running the length of the building, which in the evening radiates the heat it gained during the day; an exposed concrete slab on the first floor also serves as "thermal storage."

Advanced lighting controls save energy by turning fluorescent lights down or off when the daylight levels are sufficient. Occupancy controls reduce electricity consumption



Passive solar heating and daylighting are employed at the Center for Energy and Environmental Education at the University of Northern Iowa in Cedar Falls.

further by turning electric lights off when no one is in the room. "Low-e" argon-filled layers of glass were chosen for the windows to provide insulation, keeping heat in while letting the sun shine through. Metal overhangs shade the south windows in summer, protecting the building from overheating when the sun is high; low-angled winter sun can still enter and warm the building.

The concept of sustainability is central to UNI's environmental science curriculum. A comprehensive design process examined many aspects of energy use and environmental impact. Using daylighting design and passive solar heating reduced the need for electricity and heating fuel. Building materials were selected that required a minimum of energy to produce and transport; finishes were selected to be low-maintenance and nontoxic.

Out West...

Two Solar School Programs Launched in Colorado

Installations of photovoltaic rooftop solar systems at schools in Colorado are expected to begin this summer as part of Colorado Governor Roy Romer's Rooftop for Schools Program. Officials of Public Service of Colorado (PSCo), the utility serving about 70 percent of the state, say the Governor's program will complement their own plans for installing schooltop solar units as part of PSCo's Renewable Energy Trust.

Under the Governor's plan, schools will be eligible to receive grant money from the Office of Energy Conservation (OEC) to help purchase a rooftop PV system. With a program budget totaling about $100,000, each grant will cover 40 to 50 percent of a solar system cost, up to a cap of $7,500.

According to OEC's Adam Capage, a school system installing a two-kilowatt system could be looking at an estimated total cost between $12,000 to $15,000. The OEC program also requires that the school system include a solar educational curriculum for the students.

Andy Sulkko, product manager for marketing at Public Service of Colorado, said a two- to three-kilowatt system could provide electricity for a portable classroom or provide

equivalent power for lighting for a school library or several classrooms. He said PSCo envisions between 10 to 20 schools receiving a total of 80 kilowatts of power as participants in the utility's own effort by the year 2000.

PSCo's Solar Schools plan is an outgrowth of the tax-deductible contributions that customers are currently making to the utility's Renewable Energy Trust. Sulkko said PSCo wants to invest that money in the next couple of years "in getting a significant amount of PV on schools." In addition, they want to provide curriculum help and link the participating schools to an Internet site for measurements and comparisons of individual school solar performance. Both solar programs point to the President's Million Solar Roofs Initiative as further incentive for them to go forward. In support of the President's plan, Governor Romer has set a goal of 1,000 rooftop solar systems in Colorado by the end of the year 2000.

Contact: Adam Capage, Governor's Office of Energy Conservation, 303.620.4292, ext. 228; or Andy Sulkko, Public Service of Colorado, 303.294.2554.

Solar Energy Goes to Summer Camp in Arizona

Since 1996, the Arizona Department of Commerce Energy Office has aggressively pursued efforts to make solar energy education a prominent and permanent part of school curricula. With experience and lessons learned under the Solar Information and Education Program (SIEP) begun in 1988, and pressured by an impending end of the program budget in 1999, the Energy Office sought to incorporate solar education into existing environmental education programs. In its experience, collaboration with existing efforts, as well as with the public school system itself, was the way to succeed.

For its education program, the Energy Office chose to focus initially at the grade school level, citing studies that have shown that environmental education before and during the teen years has greatest long-term impact.

The Arizona Department of Commerce Energy Office donated a total of $25,000 for PV equipment at three educational sites. System design and installation was provided free of charge by Solar Energy International. Starting with Camp Cooper in Tucson, which had a well established Environmental Education program, they began to facilitate the crucial step to linking environmental education and stewardship with energy use and the opportunities offered by solar power.

Camp Cooper. Approximately 6,000 students learn about solar energy each year at Camp Cooper in Tucson. A direct result of this program is the incorporation of a solar energy course requirement for every fifth grade student in the Tucson Unified School District. The solar system installed at Camp Cooper provides most of the camp's energy needs. Because it is also connected to the local utility, Tucson Electric Power, the camp is able to sell the excess energy back to utility. The Energy Office estimates that the Camp saves $2,000 per

year in avoided costs plus earns $1,000 from electricity purchased by the utility. This money can be used for purchasing educational supplies, critical for cash strapped environmental education budgets.

Camp Cooper also uses a solar water heater to provide hot water for the kitchen and visiting students use solar ovens.

Camp Cooper became the model in an experiment to replicate its success in other camps, such as Camp Colton in Flagstaff.

Camp Colton. All sixth graders in the Flagstaff Unified School District spend one week at Camp Colton learning about the Arizona environment. The solar installation there provides the opportunity for hands-on learning at an already popular outdoor classroom.

The Camp Colton solar system provides enough electricity to power the entire camp. A propane generator is used only as backup, with PV displacing $500 per year in fuel costs and mitigating a potential fire hazard caused by propane lanterns.

This learning experience has recently been expanded with the creation of the Solar Energy Institute at Camp Colton during the summer of 1997. High school delegates from all over Arizona get a chance to meet with industry professionals for a week-long forum packed with lectures, tours, a hands-on research project, and a solar competition.

Red Rock State Park. The solar system at Red Rock powers a water pump used to create a wetland education project. Solar power enabled the Park to retire a noisy generator and provide the consistent quality power needed to get the project underway. Approximately 15,000 school children visit the park each year, as well as 55,000 additional visitors. Using PV saves Red Rock $500 per year in fuel costs.

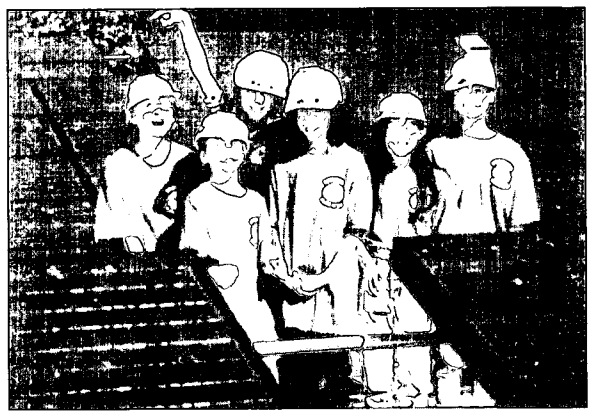
The Arizona Department of Commerce Energy Office recommends the following strategies in attempting to replicate their success:

- Seek out successful and permanent environmental education programs;
- Establish a partnership between your program and the environmental education program;
- Infuse solar education into the existing environmental education framework;
- Incorporate solar technologies into the setting where learning takes place;
- Get technical assistance for installation of the solar technology;
- Train teachers; and
- Provide an opportunity for students and the overall program to benefit from the energy produced.

Contact: James Arwood, Arizona Department of Commerce Energy Office, 602.280.1402.

California Dreaming Comes True

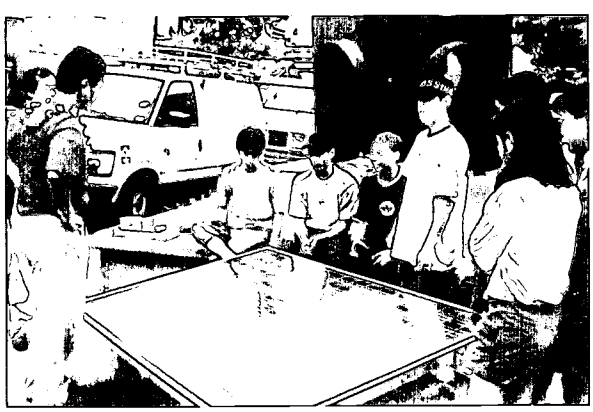
Students at Monterey Hills Elementary School in South Pasadena, California, learned a lot about solar electricity when the local utility installed photovoltaic panels on the school's roof. In 1995, Southern California Edison chose to install a 115-kilowatt solar electric system on the school to defer the cost of replacing underground electricity lines in the area. An additional attraction was the educational opportunity afforded the students.



Students at the Monterey Hills Elementary School in South Pasadena, California, learn firsthand about solar electric energy from the photovoltaic panels installed atop their school by Southern California Edison. The school was chosen for the installation in order to defer replacement of an overloaded underground power cable in the neighborhood.

Electric lines in older residential neighborhoods—built before central air conditioning, personal computers, and electrical appliances like microwaves were commonplace—can become overloaded. Supplementing overburdened lines with PV means delaying the cost and inconvenience of digging up streets and sidewalks to replace them. Electricity is vital to daily life, so utilities try to replace or upgrade circuits before they fail, but the upgrade itself may cause an interruption. "But upgrading with PV," says Edan Prabhu, manager of technology transfer at Edison, "offers an elegant way to upgrade without interrupting service."

Contact: Paul Klein, Southern California Edison. eMail: Kleinpn@sce.com.



Kaimuki High students learn more about PV technology from Hawaiian Electric Energy Specialist and Sun Power for Schools Program Manager Art Seki.

Aloha for Solar in Hawaii

The southern-most state in the U.S. has been a real hot spot for solar electric use for two reasons: the gloriously sunny climate, which is well-suited to solar use, and the expense of shipping fuels to the islands. Hawaiian Electric Company has been installing solar electric systems on schools as part of its "SunPower for Schools" program since the summer of 1997. SunPower for Schools is supported by HECO customers and the Utility PhotoVoltaic Group's *TEAM-UP* program.

Kaimuki High School in Honolulu was the first to receive a photovoltaic system on its roof, in July of 1997, followed that fall by Baldwin High School on the island of Maui. PV systems then were installed on Waianae and McKinley High Schools in January of 1998. By the end of 1998, HECO will have installed electricity-generating solar systems on at least nine schools throughout the islands.

Contact: Lynne Unemori, Hawaiian Electric Company, Inc., 808.543.7972. Internet: www.hei.com/heco.

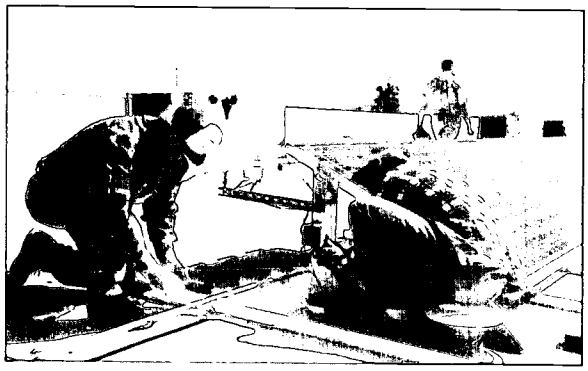
Solar Energy as Art

Each year, students at nearby elementary schools are invited to visit five solar electric systems located at Kramer Junction in California's Mojave Desert. The facility, operated by KJC Operating Company, is the world's largest producer of solar energy. Covering a thousand acres, the facility has solar collectors providing enough power for a community of 150,000 people, and has been providing southern California with reliable solar power for more than a decade.

The neighboring students are invited to celebrate Earth Day at the site, learn about solar energy and see how it works. Part of the celebration is an annual Earth Day Art Contest. The object of the contest is to get young people thinking about solar energy and how the sun's energy can be used for powering the necessities and comforts in our lives.

In 1997, about 330 student and chaperones attended the tours. In the Art Contest, one winner and two runners-up were chosen from each school that attended, and one lucky winner got to have his artwork featured on the annual Earth Day t-shirt.

Contact: KJC Operating Company, Boron, California, 760.762.5562. Internet: www.kjcsolar.com.



A four-kilowatt PV system is installed at Constitution Elementary School in Glendale, Arizona.

Arizona Utility Installs Solar on Schools

Among Arizona Public Service Company's solar installations to meet its customers' interest in PV power are a four-kilowatt PV system at Coconino High School in Flagstaff installed in early 1996 and a four-kilowatt PV system at the Constitution Elementary School in Glendale, Arizona, put in

during July of 1997.

Contact: Herb Hayden, Renewables Development Coordinator, Arizona Public Service Company, 602.250.3012. Internet: www.apsc.com.

Desert Solar

Consistently sunny, the Mojave Desert supplies ideal conditions for solar energy. At the University of Nevada in Las Vegas, nine rows of 10 solar electric modules each sit unobtrusively beside the outdoor basketball courts in the middle of campus. A chain link fence is all that separates the 18-kilowatt PV system, installed by Nevada Power Company, from the gazes of passersby. The mini PV power plant supplies electricity to a nearby student center.

Contact: Dale A. Green, Nevada Power Company, 702.227.2229.

New Mexico Annex Invites in Sun, Cuts Energy Costs in Half

The 40-year-old Architecture Annex at the University of New Mexico was remodeled during 1991 to create more space and show that significant energy cost savings could be achieved with simple, low-cost methods. Since most of the new space would be used for design studios, lighting levels were a major concern.

Existing wall areas on the south façade were replaced with windows with double glazing to increase light and passive heat gain from the sun. An interior/exterior "light shelf" system bounces light into the building while providing shade during summer months when the sun is high in the sky. The lower portion of the windows have blinds for individual control of light levels; the upper portion allows continuous daylighting. Five skylights were added to the roof to bring natural light into second-floor studio space.

All lighting fixtures were replaced with high-efficiency fluorescent lamps controlled through light-sensitive photocells which, if there is enough daylight, keep lights off even if the light switch is on. Annual electricity costs for the building dropped to half what they had been before remodeling. This decrease in electricity cost occurred even though building use has increased by about 20 percent, as more students stay for more hours a week because the building is so much more pleasant to work in!

Regeneration in California

The Center for Regenerative Studies at the California State Polytechnic University in Pomona is a model of sustainable community, where studies focus on systems capable of renewing themselves. Optimal use of solar energy was a primary shaper of design for CRS buildings, where passive solar energy provides space heating and hot water.

Earth-sheltered Commons and Sunspace buildings, situated on south-facing slopes, have heavy thermal mass to take advantage of natural heating and cooling. The buildings are heated by direct solar gain as the sun heats the floors of exposed concrete slab. Upper stories of these buildings are above ground for cross-circulation. High "clerestory" windows bring daylight into the interior. Outdoor trellises are covered with grapevines to shade windows from summer sun but allow sunlight to pass through and warm the buildings in winter.

Solar cooking is part of the curriculum as students design and build their own solar ovens—boxes covered with glass into which sunlight is reflected and concentrated—and prepare meals in them.

The Center also uses active solar, in the form of photovoltaic systems and windmills. Students grow vegetables and grain in gardens and fish in aquaculture ponds. The Center seeks to make optimum use of energy and materials available on-site, as students learn the process of living in a more sustainable way.

Contact: Sharon Stine, Department of Landscape Architecture, 909.869.4657.

Way Out West...

Australian Utility Puts PV on School Roofs

More than 7,000 customers of Integral Energy, an energy service provider in New South Wales, Australia, have donated money to a green power program designed to provide solar power (as well as a few wind and microhydropower systems) for schools.

The first Community Green Power photovoltaic installation, a one-kilowatt system, was made in January of 1998; a total of ten will be installed by July. The power outputs from the systems will be posted on the Internet, allowing students to monitor and compare system performance. Integral Energy already supplies the 600 schools in its service areas with electricity education kits; sections on renewable energy and school PV systems are being developed.

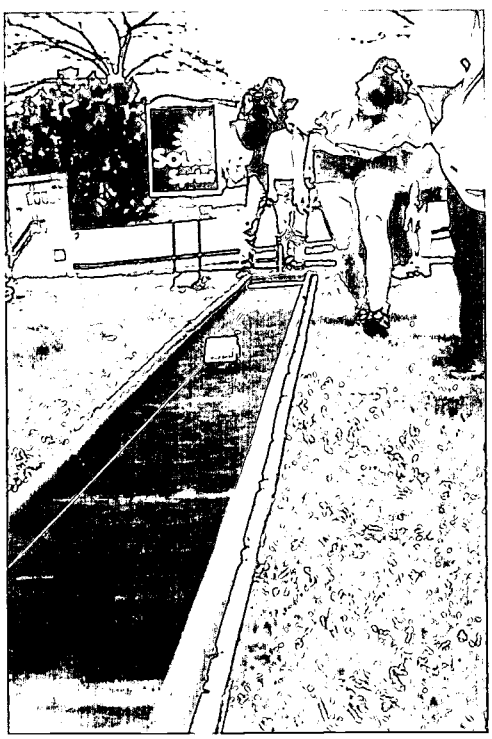
Customers contribute by rounding up bill payments or through a set amount added to their regular bills. "One customer contributes $100 every two months," says Rob Grimmett of Integral Energy. "That's putting your money where your mouth is."

Contact: Robert Grimmett, Manager of Environmental Energies, Integral Energy, South Coast Mail Centre, Locked Bag 8849, NSW 2521, Australia. Telephone: +61.42.282999.

The Sun on Wheels...

Ready, Set, Go

Students all over the country learn about the power of the sun from solar cars they make themselves. Participating students in 6th, 7th, and 8th grades receive kits with a motor and solar panel, and use their own ingenuity to provide the remaining materials. Each year, the project culminates in the Junior Solar Sprint, a chance to compete with other schools to have the first car to finish the 20-meter wired-guided race. Students learn about solar technology and combine their own creativity with that learning to become enthused about science and engineering.



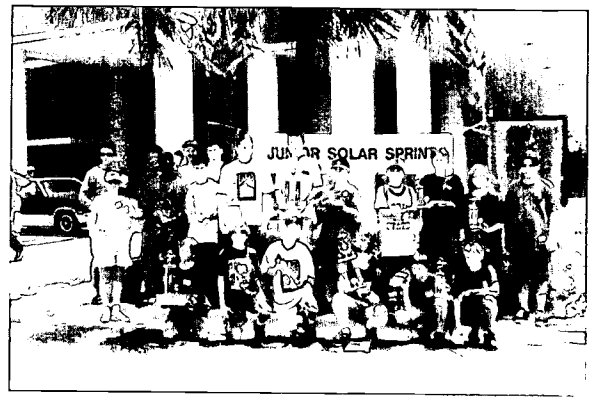
A student in Wisconsin sends her car on a Solar Sprint.

In the process, students learn how a car's weight, streamlining, rolling friction, tire pressure, wheel types, etc., affect fuel efficiency. This project gets children interested in math, science, and computers through active participation in experimentation, research, and using technology to arrive at solutions.

Students study the concepts of aerodynamics, friction, solar power, effects on the environment, decrease in pollution emissions, conservation, etc. This hands-on, minds-on approach allows students to see how all the components work together to increase efficiency and positively affect our environment.

Students employ the same process used by professional mechanical engineers when they design something new. The students build a miniature solar car and test their ideas. Students alter the wheel sizes, design transmissions, mount a solar panel—attacking the overall problem in a piece-wise fashion.

Although the race is nationally organized by the National Renewable Energy Laboratory, the actual competitions are organized and run regionally, sometimes with modified rules and regulations. Begun as a pilot project in 1990, the race grew in 1996 to 83 host sites in 26 states involving 100,000 students and 15,000 teachers.



Florida students display their winning entries and awards at a local competition.

The National JSS program is strong in areas that have teachers who write successful grants to continue the project in their regions. Since funding support from the United States Department of Energy ended several years ago, some schools have found it difficult or impossible to find the funding to supply students with solar panel kits, which cost $35 each. This year there was a large decrease in the number of schools involved in the JSS program.

Hosts can be individuals, organizations, or schools. In fact, several of the organizations and teachers profiled in this publication have organized regional competitions—Solar Now [page 16] and Hector Ibarra [page 25], just to name a few. Hosts conduct the outreach to the schools, order and distribute the car kits, provide technical mentors to the participants, and plan and manage race day.

Guidance in hosting and participating in the race is provided by NREL through its Website on the Internet [www.nrel.gov/business/education/SprintWeb] and staff support. The Website includes information on ordering kits, how to become a host, and lists of participating sites around the country. NREL also hosts a local competition in Colorado.

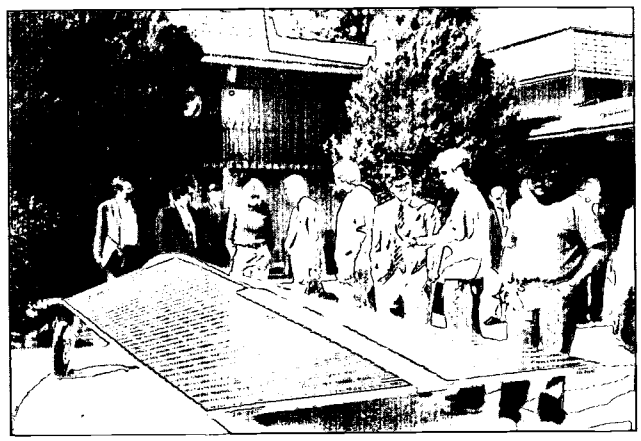
Contact: Jennifer Wieth, Education Program Administrator, 800.NEW.ENGY.

Race the Sun

The Sunrayce solar car race inspires college students all over North America to design, build, and race solar-powered cars in a challenging long-distance event. Since its inception in 1990, more than 6,000 students and over 175 colleges and universities have participated "hands-on" in Sunrayce events, whether in vehicle design and testing or in actual racing.

Held biennially, the fundamental mission of Sunrayce is to promote and celebrate educational excellence. Fueled by the spirit of friendly competition and teamwork, Sunrayce champions the creative integration of technical and scientific expertise across a range of disciplines.

The race is sponsored by General Motors, the U.S. Department of Energy, and Electronic Data Systems (EDS). Sponsors provide technical, professional, and logistic assistance to the teams, including aerodynamic analysis, photo-realistic image design, as well as supervision, coordination, and financial underwriting of the entire Sunrayce project.



Students from the New Mexico Institute of Mining and Technology entered this car in Sunrayce '97, a competition for solar-powered vehicles constructed by college students.

The Sunrayce project has spawned a wealth of innovations that have taken automotive technology a step further, with new developments in energy storage; strong, yet lightweight materials; direct drive motors; and advanced data telemetry.

EDS Student Engineering Activities supports an Internet site, at www.sunrayce.com, devoted to the collegiate car race, as well as other solar powered races: Solar Splash, an annual solar boat race in North America for collegiate teams; Formula SAE, an annual small formula car race in North America for collegiate teams; BikeRayce USA, an annual solar bicycle race for high schools teams; and Junior Solar Sprint [see page 37], annual model solar car races for middle schools' teams.

Sunrayce '99 will tentatively take place during the month of June, 1999. It will be on the East Coast, traveling north to south. Possible states/cities may include (but may not be limited to): Pennsylvania; Delaware; Maryland; Washington, D.C.; Virginia; North Carolina; South Carolina; Georgia; and Florida.

Solar Car Racing in the Movies

Catch the true story of a group of Konawaena High School students in Hawaii who, in 1990, defied critics to build a solar-powered vehicle and race in what is considered to be the most challenging of all the solar car races—the World Solar Challenge. *Race the Sun* chronicles the trials and tribulations of the determined students as they race across Australia, passing international corporate- and collegiate-sponsored teams to reach the finish line. Visit your local video store to rent the movie, starring James Belushi and Halle Berry, to find out who won.

High Schools Can Get a Head-Start

Sunrayce is committed to education at all levels. Developing interest in science, math, and engineering among the younger generation is vital to the continued growth of modern technology. Sunrayce is a excellent event to foster excitement and to showcase the application of these fields.

To complement the educational value of Sunrayce, a general science education kit has been developed. The kit is broken into two sections that include text pieces, investigations, and activities. The lessons can be used individually or together. The first section is "The Sun and Energy" and is comprised of general science lessons involving heat, light, and energy. The second section is titled "The Sunrayce and Technology" and is comprised of lessons that focus on technologies used to develop Sunrayce cars.

Everyone is welcome to use these educational materials with the hope that they provide a fun learning environment. The material is primarily targeted toward use in general science classes for the middle and high school grade levels, but may be utilized in many other areas. These materials are available on the Sunrayce website at www.sunrayce.com.

Resources

This publication has shown how various schools have incorporated energy education into their curricula. But for those schools which do not currently provide such opportunities, and for students doing their own research on renewable energy, there are many resources available at the library, by phone, and, overwhelmingly, on the Internet. Following are just some of the places to visit to learn more about solar energy and its applications.

One Stop Shopping or Six Degrees of Solar

The Center for Renewable Energy and Sustainable Technology (CREST) is possibly the best place for students to begin their Internet research on renewable energy. CREST is a nonprofit organization that uses advanced computer and communications tools to promote renewable energy, energy efficiency, and sustainable development.

CREST has produced several award-winning multimedia CD-ROMs, including "The Sun's Joules" and "The School Energy Doctor," for clients in the environmental field. Both contain educational information on solar energy, case studies, and interactive exercises for students.

CREST also established and maintains Solstice, an Internet site that links thousands of sites on renewables, energy efficiency, and the environment. Web pages for several environmental organizations are actually designed and hosted by Solstice. Others are accessed through an up-to-date network of links. Virtually any organization involved in solar energy promotion and education can be found through links started at Solstice.

Contact: www.solstice.crest.org.

Energy Department at Your Service

Another site well worth browsing is hosted by the U.S. Department of Energy (DOE). The Energy Efficiency and Renewable Energy Network (EREN) provides information on programs sponsored by DOE, including many of those listed in this publication. EREN also provides links to major organizations involved in renewable energy and energy efficiency. Parts of the site are written as an educational tool specifically for students.

One of the many links from this site is to the National Renewable Energy Laboratory (NREL) [www.nrel.gov], which is the home of the National Center for Photovoltaics. NREL

is a leader in photovoltaic research, providing a wealth of information on cutting edge technology and applications.

For those without access to the Internet, much of the same information can be obtained by telephone through EREN's sister service, the Energy Efficiency and Renewable Energy Clearinghouse. Fact Sheets are available on basic technology, DOE programs, and much more. A well-trained technical staff is on-hand to answer more in-depth inquiries.

Contact: EREN, www.eren.doe.gov. EREC, 800.DOE.EREC.

NEED–Promoting Wise Energy Use Through Education

The National Energy Education Development (NEED) Project, a nonprofit organization based in Herndon, Virginia, promotes energy education among U.S. schools as a means to encourage intelligent decisions on a national basis about energy resources and energy use.

NEED issues an annual energy education report card that takes the measure of the "energy literacy" of middle and secondary school students. NEED develops and distributes curricula that cover all forms of energy, including solar, and recognizes students and teachers who demonstrate leadership in energy education.

In September, 1998, NEED is staging an Energy Summit in Washington, D.C., and in schools around the country to focus attention on energy issues 25 years after the crisis sparked by the Middle East oil embargo. A key topic of the Summit will be an examination of what the U.S. has done to change energy habits and to develop energy alternatives such as solar in the years since the oil embargo.

For more information, contact: Gerard Katz, President, NEED Project, 102 Elden Street, Suite 15, Herndon, VA 20170. Telephone: 703.471.6263. eMail: need@erols.com. Internet: www.need.org/need.

Surfing With Solar...

Go on-line to find an intricate web of hundreds of associations promoting and using solar energy.

The list that follows is just a sample of the resources available to students and teachers to learn more about solar energy technology and applications. Most of these energy websites include links to other organizations, which will help you find great information on people and places you didn't even know about.

Alliance to Save Energy

www.ase.org

A nonprofit coalition of prominent business, government, environmental, and consumer leaders who promote the efficient and clean use of energy worldwide to benefit the environment, the economy, and national security.

American Solar Energy Society

www.ases.org/solar

The American Solar Energy Society (ASES) is a national organization dedicated to advancing the use of solar energy for the benefit of U.S. citizens and the global environment. ASES promotes the widespread near-term and long-term use of solar energy. ASES has regional chapters throughout the country and is the United States Section of the International Solar Energy Society.

California Energy Commission

www.energy.ca.gov/education

The California Energy Commission has an award-winning Internet site on energy education for students, parents, and teachers called Energy Quest.

Centre for the Analysis and Dissemination of Demonstrated Energy Technologies Renewable Energy Center

www.caddet-re.org

CADDET offers information on full-scale commercial projects which are operating in member countries. This information is made available through a renewable energy data base of full-scale projects, available on-line; a quarterly renewable energy newsletter; a technical brochure; case studies of selected renewable energy projects; and reports which follow up on topics of interest.

Colorado Governor's Office of Energy Conservation

www.state.co.us/gov_dir/oec

The Governor's Office of Energy Conservation (OEC) is a state agency operating as a part of Gov. Roy Romer's office. OEC offers energy information and services to individuals, communities, schools, hospitals, businesses, and government agencies. Details on solar energy initiatives in Colorado is featured under "Current OEC Programs and Initiatives."

The Electric Power Research Institute

www.epri.com

The Electric Power Research Institute delivers the science and technology to make the generation, delivery, and use of electricity affordable, efficient, and environmentally sound. Created by U.S. electric utilities in 1973, EPRI is one of America's oldest and largest research consortia, with some 700 members and an annual budget of about $500 million.

Energy Information Administration

www.eia.doe.gov

The Energy Information Administration is the independent statistical and analytical agency within the U.S. Department of Energy.

The Energy Foundation

www.ef.org

The foundation's mission is to assist in the nation's transition to a sustainable energy future by promoting energy efficiency and renewable energy. It functions primarily as a grant-maker, but when it determines there is an unmet need in the field, it may convene workshops, commission papers, or take other direct initiatives.

The Florida Solar Energy Center

www.fsec.ucf.edu

The energy research institute of the State of Florida, the Center is nationally recognized for comprehensive programs in solar energy and energy efficiency. FSEC operates within the State University System and is administered by the University of Central Florida.

The Global Energy Marketplace (GEM)

gem.crest.org

This powerful, on-line, searchable database of more than 2,500 energy efficiency and renewable energy annotated Web links is sponsored by the U.S. Environmental Protection Agency and created by CREST to promote a more sustainable energy future and mitigate global climate change that results from energy use. The site contains highly useful case studies, reports, publications, economic analyses, product directories, discussion groups, country profiles, mitigation assessments, and other beneficial resources.

The International Solar Energy Society

www.ises.org

The International Solar Energy Society (ISES) represents an international network of scientists, businesspeople, and decision makers in more than 118 countries around the world. These form a Global Alliance aimed at the advancement of renewable energy through research, technology transfer, commercialization, and education.

The Interstate Renewable Energy Council

www.irecusa.org

IREC works to accelerate the sustainable utilization of renewable energy sources and technologies in and through state and local government activities. IREC supports market-oriented services targeted at education, coordination, procurement, technology transfer and linkage with national laboratories and associations, collaboration with industry, uniform guidelines, and customer protection. IREC's members include state energy offices, other municipal and state agencies, national laboratories, solar and renewable organizations, and individual members.

A major program administered by the Interstate Renewable Energy Council is **Photovoltaics for Utilities (PV4U)**. The PV4U State Working Groups bring together key energy stakeholders from the electric regulatory community, the utility industry, state government, consumer advocate and public interest organizations, and the photovoltaics industry to participate in the collaborative process to commercialize photovoltaics at the state level. The fundamental role of the PV4U State Working Groups is to identify regulatory, policy, and institutional barriers to PV deployment and to develop strategies to overcome these barriers. The states currently active in the PV4U program are: Arizona, California, Colorado, Delaware, Florida, Hawaii, Idaho, Maryland, Massachusetts, Nevada, New York, North Carolina, Texas, Virginia, and Wisconsin.

The National Center for Photovoltaics

www.nrel.gov/ncpv

The Center merges the core photovoltaic expertise of the National Renewable Energy Laboratory (NREL), Sandia National Laboratories, Brookhaven National Laboratory, and the U.S. Department of Energy's (DOE) Centers of Excellence in PV at the Georgia Institute of Technology and the Institute of Energy Conversion at the University of Delaware. That expertise is further strengthened by partnerships with dozens of university and industry researchers across the country. The NCPV serves as DOE's initial point of contact for potential investors, customers, manufacturers, and distributors interested in all aspects of photovoltaic technology and applications.

National Energy Information Center

www.eia.doe.gov/neic/education/contents.htm

Energy Education Resources: Kindergarten Through 12th Grade is published by the National Energy Information Center (NEIC), a service of the Department of Energy's (DOE) Energy Information Administration (EIA), to provide students, educators, and other information users with a list of generally available free or low-cost energy-related educational materials.

The National Network of Energy and Environmental Education Professionals

www.leeric.lsu.edu/network/network.htm

The Network is comprised of energy and environmental education professionals from government, business, and nonprofit organizations. Members include experts in a wide range of disciplines and fields who are willing to provide program assistance in areas such as curriculum development, evaluation, incorporating the arts, technology, and marketing. Contact: Bob Bradley, Director, Louisiana Energy and Environmental Resource and Information Center (LEERIC), Louisiana State University, One East Fraternity Circle, Baton Rouge, LA 70803.

The North Carolina Solar Center

www.ncsc.ncsu.edu

The North Carolina Solar Center, located in the College of Engineering at North Carolina State University, provides programs and resources which help people throughout North Carolina take advantage of solar energy. Services available to the public include a toll-free hotline, a referral network of professionals, technical and design assistance, free publications, curriculum materials for teachers, training sessions, tours of a demonstration Solar House, and a reference library. For more information, contact the N.C. Solar Center by phone at: 800.33.NC SUN (toll-free in N.C.), or 919.515.3480. eMail: ncsun@ncsu.edu.

Northeast Sustainable Energy Association

www.nesea.org

NESEA is a nonprofit 501(c)(3) membership organization. It was founded in 1974 to foster the use of renewable and sustainable energy, the responsible use of nonrenewable forms of energy, and to convey the value of these practices for the preservation of the environment.

Passive Solar Industries Council
www.psic.org

PSIC is a national resource for information to make buildings energy-efficient, more comfortable, less expensive to operate, environmentally sound, and capable of stimulating greater occupant productivity.

Solar Energy Industries Association
www.seia.org

SEIA has been the national trade group for the commercial enterprises involved in solar energy for more than 20 years. SEIA is based nationally in Washington, D.C., at 122 C Street, N.W., Washington DC 20001, and can be reached at 202.383.2600. SEIA also has regional chapters throughout the country.

Solar Energy Research and Education Foundation
www.seref.org

The Solar Energy Research and Education Foundation (SEREF) is a nonprofit organization whose purpose is to develop and disseminate educational material regarding solar and other alternative energy sources. SEREF is involved with development of both printed and electronic curriculum materials, and is closely linked with the network of U.S. renewable energy trade organizations in Washington, D.C. SEREF is located at 122 C Street, N.W., Suite 400, Washington, DC 20001.

University Center of Excellence for Photovoltaics Research and Education
www.ece.gatech.edu/research/UCEP

The U.S. Department of Energy (DOE) established a University Center of Excellence for Photovoltaics Research and Education (UCEP) at Georgia Institute of Technology, one of two such centers in the United States. The mission of the Center is to improve the fundamental understanding of the science and technology of advanced PV devices, to fabricate record high-efficiency solar cells, to provide training and enrich the educational experience of students in this field, and to give the U.S. a competitive edge by providing guidelines to industry and DOE for achieving cost-effective and high-efficiency PV devices.

Utility PhotoVoltaic Group
www.ttcorp.com/upvg

The Utility PhotoVoltaic Group (UPVG) is an association of more than 90 energy service providers from the U.S., Canada, Europe, the Carribean, and Australia cooperating to increase the commercial use of solar electricity. An Internet version of this "Schools Going Solar" brochure can be accessed at the UPVG Website.

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Boulder, Colorado 80301
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303.443.3212 fax
eMail: ases@ases.org
Website: www.ases.org/solar

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Energy Efficiency and Renewable Energy Clearinghouse (EREC)
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Website: www.eren.doe.gov

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