ecological modular and affordable housing

John Quale
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	UNAIDED CLIENT	PHA CLIENT	PHA CLIENT LIVING IN OUTin		
			Saving Level 1	Saving Level 2	Saving Level 3
Appraisal Value	$282,000	$282,000	$282,000	$282,000	$282,000
CAAR Workforce Housing Fund	12,000	12,000	12,000	12,000	12,000
Albemarle County Fund	16,000	16,000	16,000	16,000	16,000
PHA Subsidy (20%)	0	56,400	56,400	56,400	56,400
Sum of Mortgage	**$254,000**	**$197,600**	**$197,600**	**$197,600**	**$197,600**
Lifetime Saving from Green Design (1)	$0	$0	$6,600	$15,000	$22,000
Inflation	3.00%	3.00%	3.00%	3.00%	3.00%
Mortgage Interest(2)	6.50%	4.50%	4.50%	4.50%	4.50%
Monthly Rate	0.54%	0.38%	0.38%	0.38%	0.38%
Payment Period	360	360	360	360	360
Monthly Mortgage Payment	$1,605.45	$1,001.21	$1,001.21	$1,001.21	$1,001.21
Reduced Burden from Green Design (3)	$0.00	$0.00	$27.83	$63.24	$92.75
Actual Burden	$1,605.45	$1,001.21	$973.38	$937.97	$908.46
Monthly Income (4)	$6,175	$3,851	$3,744	$3,608	$3,494
Annual Household Income Required	**$74,098**	**$46,210**	**$44,925**	**$43,291**	**$41,929**

1. Green Designs reduce expenses in electricity and water. 30 year savings are determined at present value.
2. PHA enables its lower income buyers to acquire houses at a subsidized annual mortgage rate of 4.5%
3. Derived from the monthly value of the lifetime savings from Green Design using assumed average rate of inflation.
4. 26% of monthly income is assumed to be the level of financial burden a family can afford.

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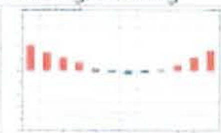
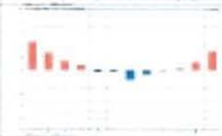
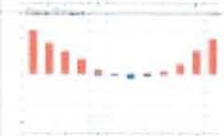
ecoMOD Energy Modeling

OUTin House

Module	Activities	Location	Solar Access	Ventilation	R-Value	Heating/Cooling	Appliances	Environmental Criteria
Living Room	Entertaining Eating a Meal Greeting Guests				Walls South: 25 West: 10.913 North: 25.000 TOTAL: 22.69 Roof: 38		Lamps Television Sound Equipment	BAY WINDOW- Allows trickle ventilation to allow fresh air exchange. Provides natural ventilation and daylighting into interior spaces.
Kitchen and Dining	Preparing and Eating Meal Entertaining Greeting Guests				Walls South: 17.403 North: 22.832 TOTAL: 19.01 Roof: 38		Dishwasher Stove/Oven Microwave Lamps HVAC Equipment	HIGH EFFICIENCY APPLIANCES- Energy Star rating on all major appliances used in the kitchen. COMPOSTING AND GARDENING- Vegetation on site available for food resource. WATER FROM COLLECTION- water used in the kitchen from rainwater collection at entry.
Stair and Entry	Greeting Guests				Walls South: 22.599 North: 24.405 TOTAL: 23.442 Roof: 38		Computer Lamps	SKYLIGHT- Skylight allows daylighting in stairs during all times of the year.
Bath and Laundry	Laundry				Walls South: 25.000 East 22.3 North: 16.16 TOTAL: 21.101 Roof: 38		Lamps Washer Dryer Iron	HIGH EFFICIENCY WASHER AND DRYER- Front loading of washer and dryer also allows for minimal use of water. OUTSIDE CLOTHESLINE RAINWATER COLLECTION USED IN APPLIANCES- Water used in the washer and dryer is collected from roof rainwater system.
Bedroom 1	Getting Up and Ready for Bed				Walls South: 25.000 East 22.486 North: 23.744 TOTAL: 23.711 Roof: 38		Lamps Computer Television Radio	SLEEPING PORCH- Possibility of sleeping outdoors in a safe environment during fair weather. RAINWATER COLLECTION- Use of rainwater in bathrooms for sink, shower, and toilet. SOLAR HOTWATER PANELS- Used for heating water in bathrooms.
Full Bath	Showering Getting Up and Ready for Bed				Walls North: 23.223 TOTAL: 23.223 Roof: 38		Lights Hairdryer	RAINWATER COLLECTION- Use of rainwater in bathrooms for sink, shower, and toilet. SOLAR HOTWATER PANELS- Used for heating water in bathrooms.
Bedroom 2	Getting Up and Ready for Bed				Walls South: 23.867 TOTAL: 23.867 Roof: 38		Lamps Computer Television Radio	RAINWATER COLLECTION- Use of rain water in bathrooms for sink, shower, and toilet. SOLAR HOTWATER PANELS- Used for heating water in bathrooms.
Master Bedroom	Getting Up and Ready for Bed				Walls South: 22.103 West: 19.554 North: 25.000 TOTAL: 21.800 Roof: 38		Lamps Computer Television Radio	CROSS VENTILATION- Window placement allows for cross ventilation and daylighting of interior spaces.

Feature from **Environmental Building News** PRINT EMAIL
May 2006

Checklist: Passive Survivability: A Checklist for Action

Create storm-resilient buildings.

Design and construct buildings to withstand reasonably expected storm events and flooding. One should assume that storm events will become more common and more intense in the future, and that regions prone to severe storms will expand in area. More stringent design and construction standards, such as the Miami – Dade County Building Code, should be adopted widely.

Limit building height.

Most tall buildings, with their dependence on electrically powered elevators and their relianc conditioning, usually cannot be used in the event of power outages. The occupant density in buildings generally precludes providing a significant fraction of power requirements with ons renewable sources, and in a development pattern with a lot of tall buildings, blocking solar a of other buildings is a significant concern. In *Adapting Buildings and Cities for Climate Chan* authors recommend six to eight stories as a reasonable height limit.

Create a high-performance envelope.

High levels of insulation, high-performance glazings (with multiple low-emissivity coatings a conductivity gas fill), and airtight construction are critical in achieving passive survivability i buildings. High levels of energy performance of the envelope (superinsulation) are particula important with smaller, skin-dominated buildings.

Minimize cooling loads.

Reduce unwanted solar heat gain by paying careful attention to building orientation (situatir buildings on an east-west axis with the long façades facing south and north), minimizing ea west-facing glazings, specifying glazings "tuned" to the orientation (using low solar-heat-gai coefficient glazings on the east and west, for example), using overhangs and other building geometry features to shade glazings, and selecting vegetative plantings that will shade the buildings (particularly the east and west façades).

Provide for natural ventilation.

In addition to reducing unwanted solar gain, design buildings to provide for natural ventilati Even if the building is designed to operate with conventional air conditioning, provide operal windows, natural stack-effect cooling towers, and other features that can provide passive ventilation and cooling when necessary—even if using such strategies will result in higher-th desired humidity levels in the building.

Incorporate passive solar heating.

Particularly with smaller, skin-dominated buildings, provide passive solar design features, su direct solar gain with interior thermal mass, thermal storage walls (Trombe walls), and suns or other isolated-gain solar systems.

Provide natural daylighting.

The following strategies can optimize daylighting design while minimizing unwanted heat ga provide windows high on exterior walls; specify glazings with high visible-light transmission low solar-heat-gain coefficient; install lightshelves to reflect light deep into the space; instal skylights with provisions to prevent overheating; paint ceilings and walls with high-reflectan paints; consider clerestory windows and light monitors to bring light deep into buildings; uti wells and atria to extend daylighting to lower floors of larger buildings; in buildings with ver floorplates, consider light-scoop and mirror systems to improve daylight distribution in the i space.

Provide solar water heating.

To provide hot water during power outages or fuel supply interruptions, install solar water h systems that can operate passively (thermosiphoning or batch/integral-collector-storage) or operate with DC pumps powered by integrated photovoltaic (PV) modules.

Provide photovoltaic power.

Capability to power a building with PVs is invaluable during outages. To be able to rely on P during a power outage for nighttime electricity necessitates battery storage, which increase system cost substantially (but may be justified for the value provided). Be sure to mount PV modules in a manner that will protect them during storms. Wire the building to isolate critic so that they can be PV powered when the rest are cut off.

Configure heating equipment to operate on PV power.

The vast majority of gas- and oil-fired heating equipment cannot operate without electricity. Providing the capability to operate that equipment during a power outage—using either a ge or a PV power system—is clearly beneficial. To simplify switching over to PV operation durin outage, equipment should be redesigned to operate on DC power; even without battery stor some operation of heating equipment would be possible during a 24-hour period.

Where appropriate, consider wood heat.

In more rural areas, install low-pollution-emitting wood stoves, masonry heaters, or pellet s (with back-up power for fan) to provide space heating in the event of an extended power ou fuel-supply interruption.

Store water on site; consider using rainwater to maintain a cistern.

Provide water storage to serve the building during an extended loss of water. Ideally, store water high in the building, such as on the rooftop, to facilitate gravity delivery. In cohousing

communities and planned neighborhoods, shared water systems can be developed with grav
to dwellings. Cisterns can be fed with rainwater and used during normal building operation f
landscape irrigation and, depending on local permitting, for toilet flushing—as long as an ad
reservoir is maintained for emergency use. Such cisterns can also serve fire suppression nee

Install composting toilets and waterless urinals.

Composting toilets and waterless urinals can be used in the event of water loss, and compos
toilets can function even if the municipal sewage treatment plant shuts down. In a large bui
with conventional toilets, such as an apartment building, consider installing one or two high-
capacity composting toilets in a common area for use if water supply is cut off or the sewer
fails.

Provide for food production in the site plan.

Whenever possible, provide for local food production in the site planning for a building or development. Consider setting aside the best land for agricultural uses and planting food-be
trees and shrubs in the landscaping mix.

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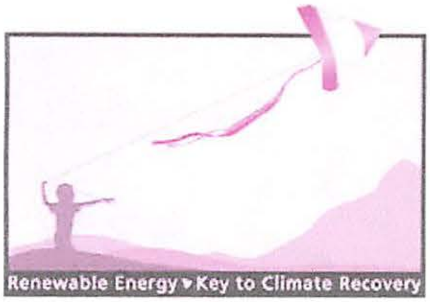

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Plenary Sessions at SOLAR 2006 focused on the conference theme, and showcased speakers of the highest caliber – the acknowledged leaders of the Renewable Energy and Global Climate Change Research communities.

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SOLAR 2006 speakers generally prepared a Powerpoint presentation. If we received permission from the presenter, the Powerpoint presentation is available here. Click on the title of the Presentation to open a PDF version.

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MONDAY, JULY 10, 2006

8:00am to 10:00am

PLENARY - Latest Climate Change Knowledge

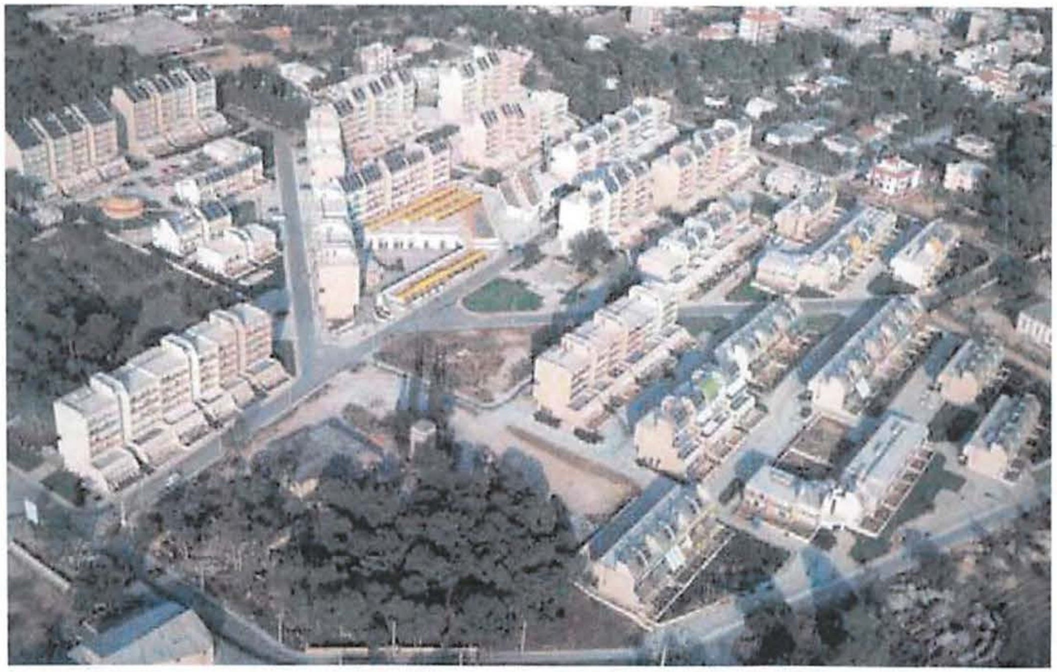
Moderator: Dr. Chuck Kutscher, SOLAR 2006 National Organizing Committee Chair

- *Climate Modeling of the 20th and 21st Centuries*
  Dr. Warren M. Washington, Senior Scientist and Head of the Climate Change Research Section in the Climate and Global Dynamics Division at the National Center for Atmospheric Research (NCAR)
- *The Threat to the Planet - Actions Required to Avert Dangerous Climate Change*
  Dr. James Hansen, Head, NASA Institute for Space Studies, a division of Goddard Space Flight Center's Earth Sciences Directorate

Common design features of Pefki

Bartlett School of Graduate Studies

- The majority of main elevations, openings, terraces and balconies are south facing.
- Flats are arranged on an east-west long axis.
- Northern openings are restricted to a minimum to reduce heat losses in winter.
- No East or West openings exist, to avoid high solar gains in summer.
- Natural cooling is achieved through the narrow plans of the flats and the North and South openings that provide cross ventilation.



good information on resident usage of features p19-p26

Feature from **Environmental Building News** PRINT EMAIL
May 2006

Passive Survivability: A New Design Criterion for Buildings

In December 2005 an editorial in *EBN* introduced the concept of "passive

Cooling-load avoidance strategies, like the shades on the southwestern windows of the combined Langston High School and Langston-Brown Community Center in Arlington, Virginia, help maintain livable thermal conditions in a building even when the power goes out.

survivability," or a building's ability to maintain critical life-support conditions if services such as power, heating fuel, or water are lost, and suggested that it should become a standard design criterion for houses, apartment buildings, schools, and certain other building types (*EBN* Vol. 14, No. 12). Since then, the term has begun creeping into the lexicon of green building, though we have a long way to go before the mainstream building industry takes notice.

In this article we examine the concept of passive survivability in greater detail and address some specific strategies that can be employed in adopting this design criterion for buildings.

The Vulnerability of Buildings

While Hurricane Katrina wasn't the first natural disaster to affect an entire city, and it certainly won't be the last to

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cause widespread power outages and damage to buildings, it may have been a turning point—both in our acceptance that global warming is real and in our awareness of the vulnerability we face in the years and decades ahead. Visionary thinker Gil Friend suggested in a recent essay that someday we will look back at 2005 as a tipping point. "The fact- and science-averse among us may still claim to not be persuaded about global warming, but I'll wager that everyone else got the message in 2005," he wrote in "Sustainability—At the Tipping Point?" in his online newsletter, *The New Bottom Line* (www.natlogic.com).

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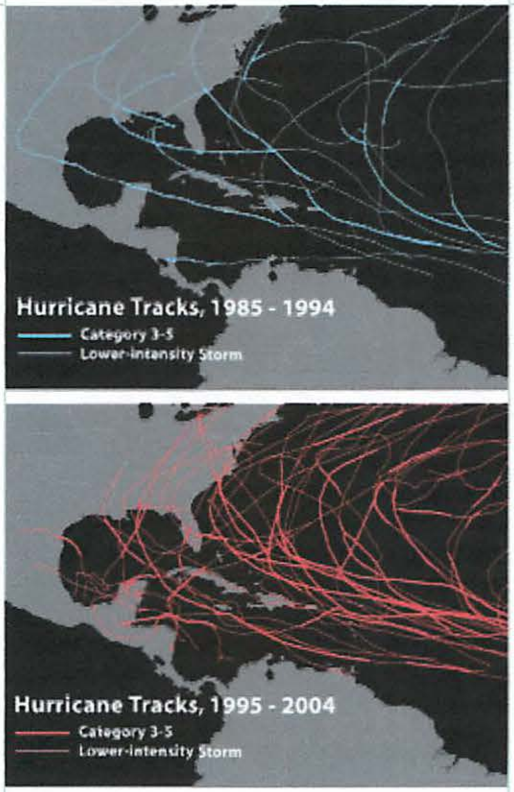


A dramatic increase in the frequency and severity of tropical storms affected the Gulf Coast in the decade from 1995 to 2004 compared with the previous ten-year period. Ocean surface temperatures in the most recent period were 1°F to 2°F (0.5°C to 1.1°C) warmer, driving this increase in storm activity.

As the storm track images clearly convey the frequency and the magnitude of tropi storms affecting the Gulf Coast and coast Atlantic states increased dramatically in t decade 1995 to 2004 compared with the previous decade. Other, longer-term, sci studies have demonstrated that at least t *severity* of tropical storms has been incre as an effect of global warming, even if th still out on the *frequency* of storms.

The potential for rising sea levels has als in the news a great deal recently. New ev shows that the Greenland ice sheet is me faster than expected. This and the calvin large ice sheets in Antarctica (some as la small states) raise the specter of significa higher sea levels. With 53% of the U.S. population living on land defined as the c zone, rising sea level is a major concern. University of Arizona Department of Geo Environmental Studies Laboratory websit dramatically illustrates rising sea level: www.geo.arizona.edu/dgesl/ (click on "D maps of areas susceptible to sea level ris ").

Low-lying areas prone to tropical storms flooding are not alone in being vulnerable extensive ice storm in eastern Canada in left 4 million people without power for an extended period and forced 600,000 peo their homes—which could not be heated electricity. A heat wave in Chicago killed then 700 people in their homes or apartn 1995; a more severe heat spell in 2003 killed 30,000 people in Europe. A widespread power in the eastern U.S. and Canada in 2003 left 50 million people—one-seventh of the U.S. popu and one-third of the Canadian population—without power; fortunately, weather conditions w moderate.

Adding to these risks is terrorism. Following the 9/11 attacks in the U.S., Americans will for aware of their vulnerability to terrorism. Power and natural gas distribution systems are par exposed and susceptible to interruption, with large centralized trunk lines running through r areas. The extensive power outage in 2003, caused by a circuit overload or malfunction, demonstrated this risk; well-placed explosives could even more effectively cut off power to l areas. "The blackout in the Northeast in the summer of 2003 and Katrina should be enough make it clear that we have a serious problem," notes David Eisenberg, of the Development (for Appropriate Technology (DCAT) in Tucson, Arizona.

Often neglected in discussions about terrorism is the risk of *cyberterrorism*. "By hacking intc systems of the utility grid," according to Joel Gordes, of Environmental Energy Solutions in \ Hartford, Connecticut, "it is possible to incapacitate the system for as long as a week with li effects remaining for as long as 18 months."

Finally, we are vulnerable to energy supply shortages. The petroleum age will effectively en within the expected lifetimes of buildings being designed and built today. Most resource exp policy makers assume that by the time petroleum "runs out," alternative energy sources wil available to replace that lost energy. However, during the period of transition to next-gener fuels, or if replacement fuels do not become available quickly enough to displace dwindling s of fossil fuel, there may be significant energy shortages. Natural gas, heating oil, and electri derived from fossil fuels could all become scarce or prohibitively expensive.

Defining Passive Survivability

In preparing for a series of charrettes on Gulf Coast reconstruction for the Greenbuild confe November 2005, the term passive survivability emerged as an umbrella concept to convey t of buildings that maintain livable conditions in the event of extended power outages, interru of fuel supply, or loss of water and sewer services. High temperatures in the Superdome—th emergency shelter—had put evacuees at risk, contributing to uproar across the country.

This made us wonder about the schools around the country that are commonly designated a shelters, as well as our houses and apartment buildings. If storms are becoming more inten more common, and if our energy distribution systems or energy supplies are becoming mor vulnerable, shouldn't we be designing our buildings to be able to function—at least minimall provide basic livability—in the event of power outages or interruptions in fuel or water suppl Shouldn't passive survivability, we asked ourselves, be a basic design criterion of buildings i day and age?

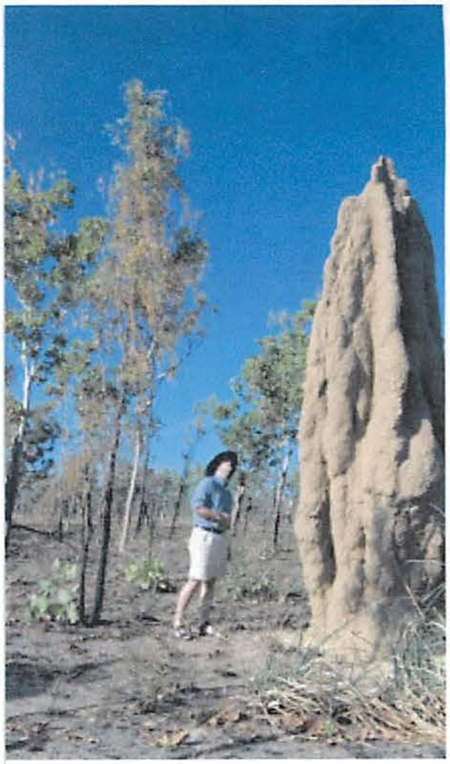
Achieving Passive Survivability

In some ways, the failure of conventional buildings to maintain survivable conditions can be thought of as a failure of design. "If they lose only electricity," notes building researcher Ter Brennan, of Camroden Associates, Inc., in West-moreland, New York, "few buildings in the l provide as much comfort as my backpacking tent; if the gas lines and water lines go, the sit is even worse."

Some strategies for passive survivability can be found by looking back at our building herita vernacular designs that were in place before electricity and readily transportable fuels becar available. The wide-open and well-ventilated "dog-trot" homes of the Deep South are exam are the high-mass adobe buildings of the American Southwest.

The house designs of some animals display even better examples of passive survivability. Among the best are termite mounds of Africa and Australia (see photo). "With a single ganglion for using no electricity or fossil fuels, termites construct dwellings that maintain temperature, h and ventilation better than most buildings," says Brennan.

Marc Rosenbaum, P.E., of Energysmiths in Meriden, New Hampshire, says generators are th survivability focus in large buildings, but these are really designed for short-term power outages. "It's rare that anyone is looking for 24 hours of continuous operation." With typical buildings, Rosenbaum hasn't seen any planning for longer outages, which are among his arguments for incorporating daylighting and operable windows.



Termites maintain remarkably constant thermal conditions in their mounds, such a this one in Australia.

Sidebar:

Marc Rosenbaum on passive survivability at his own house

EBN Advisory Board member Marc Rosenbaum shared with us how he hi addressed passive survivability in his N Hampshire home:...

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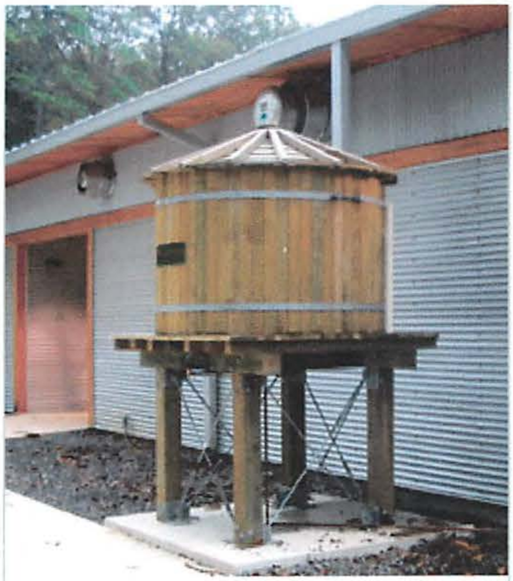
Fortunately, we are beginning to pay attention. "Disaster tolerance is of growing interest to many groups," says John Straub, Ph.D., an engineer and building science expert at the University of Waterloo in Ontario. "I like the term 'robust designs,' since this encompasses weather, energy, extreme people, changing times, etc." Straub argues, for example, that stairwells should be built with windows, and offices should be daylit and have the potential for natural ventilation. "High insulation and h mass with some passive solar gain and summer shading will dramatically improve survivabil Straub told *EBN*.

A 21,000 ft^2 (2,000 m^2), five-story apartment building that Straub helped design, and lives incorporates a wide range of passive survivability measures, including high levels of insulati passive solar features, and natural ventilation. The design team specified the heating systen have a very low electrical draw—just 250 watts operate the pumps and fans for the entire building—so that they can use a photovoltaic-charged battery pack to operate the natural-g heating system in the event of a power outage.

While maintaining livable thermal conditi generally gets the most attention relative passive survivability, water is also very important. "We can live without many things," notes York City developer Jonathan Rose, "but water is essential." A good start, suggests Brennan install composting toilets and waterless urinals, neither of which require water to operate.



This 700-gallon (2,600 l) cistern stores rainwater for the Camp Aldersgate Commons Building in Little Rock, Arkansas.

While passive survivability features can b incorporated into virtually any building, tl features are most important for buildings are lived in or likely to be used as emerg shelters: houses, apartment buildings, sc hospitals, emergency-service buildings, a government buildings. The strategies diff somewhat by building type; the need for performance building envelope, for exam greater in smaller buildings that are skin-dominated (where heating and cooling lo determined primarily by energy flow thro building envelope) than it is in large, loac dominated buildings.

A number of the most important design a construction strategies for achieving pass survivability in new buildings are address the checklist.

Passive Survivability and Building Codes

Checklist:
Passive Survivability: A Checklist f Action

Classrooms at the Kirsch Center for Environmental Studies in Cupertino, Califo feature ceiling fans and operable windows maximize daylighting and natural ventilatic

David Eisenberg, whose organization, DCAT, has been working to integrate aspects of sustainability into building codes for the past ten years, points out that the purpose statement in the International Building Code states that codes should "safeguard public health, safety, and general welfare from hazards attributed to the built environment." "When a building is unable to provide a safe and habitable environment," says Eisenberg, "it fails to meet this standard of responsibility." He believes that this should apply whether all of the building's assumed utilities are functioning or not. "We should not be designing, approving, and constructing buildings that kill people when they are disconnected from their external utilities," Eisenberg told *EBN*.

Eisenberg is not aware of any building codes that address passive survivability. He expects that the same forces that opposed energy codes a indoor air quality standards will oppose anything like this getting into the codes. "At the ver he argues, "the code organizations should be working to make it easier, rather than more di to gain code approval for such designs."

"Codes are very reactive and so have not been doing anything about this as far as I know," Straub. When codes do address survivability, they go about it the wrong way, in his opinion prefer active systems that routinely fail and need lots of ongoing maintenance," he says, "lil up generators to run lights in windowless stairwells."

A few elements of passive survivability are beginning to find their way into building codes ar related regulations. The City of Chicago, for example, has passed an ordinance requiring all buildings to have reflective roofs, according to Sadhu Johnston, commissioner of the City's Department of the Environment. "Our progress toward greener buildings continues to grow, by default, has passive survivability gains," Johnston told *EBN*.

Gordes notes that in general the only passive survivability measures that have been incorpo into building codes are those providing storm resilience—such as the Miami – Dade County hurricane codes. He suggests that demand for such codes may come from another major pl believe we may find support for some aspects of green or survivable buildings within the ins industry, which has an interest in mitigating losses and protecting lives," he says. "Just as tl have been champions in fire-suppression sprinklers, they may support code upgrades for m green building attributes."

Final Thoughts

When one looks through the collection of passive survivability strategies addressed in this a becomes immediately obvious how closely they match a general list of green building strate Indeed, most of the measures that make our buildings more passively survivable also make buildings more environmentally responsible.

Passive survivability strengthens the case for green buildings. Most of us in the green buildi community probably don't need another reason; we seek to create green buildings because know that they are better for the people living in them and better for the Earth. But getting designed and built isn't always easy in the face of financial and regulatory obstacles and jus inertia. To overcome these barriers, it may help to make the case that these buildings are m resilient and better able to protect the well-being of Americans in the aftermath of natural d or terrorist actions. Sometimes it's useful to respond to people's fears as well as their aspira and passive survivability does just that, without an antisocial survivalist agenda.

The next step in advancing the agenda of passive survivability should be a collaborative effo involves the design community, code organizations, the insurance industry, and nonprofit sc welfare organizations. The sustainability community could play a lead role in convening such initiative. "Life safety should be the bottom line in this, and it would be gratifying to see a collaborative effort develop to address this issue," says Eisenberg.

– Ale.

DISCUSSIONS

Reader-contributed comments related to *EBN 15:5 - Passive Survivability: A New Design Cr for Buildings*. Comments are listed with newest at the top.

Air quality *Posted by Chip Tittmann on May 30, 2006, 04:31 PM*
I'm curious what air quality you are concerned about considering that there are now approv unvented propane and gas heaters, stoves, ranges and boilers. Are you saying that nuclear natural gas produced electricity is better for the air quality than supposedly clean exhausts propane or natural gas?

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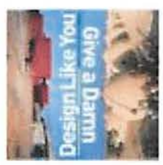

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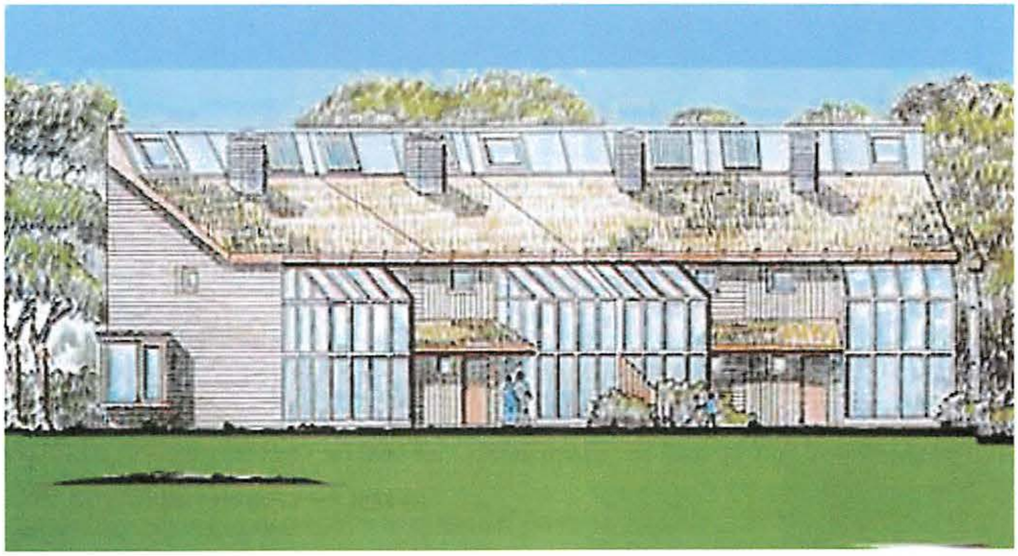
Design of a Co-operative Housing Community

Passive Solar



Passive solar energy is nothing new. About 14% of space heating in an ordinary British home comes from solar energy through walls and windows. Passive solar design tries to optimise the amount of energy that can be derived directly from the sun. Over 25% of UK primary energy goes towards heating buildings, more than for any other purpose. By incorporating passive solar design into new buildings, annual fuel bills can be cut by about a third, with corresponding carbon dioxide savings. This helps to reduce global warming.

In addition, the increased daylight means that the need for additional electric lighting is lowered. Passive solar design can be best applied in new buildings, where the orientation of the building, the size and position of the glazed areas, the density of buildings within an area, and materials used for the remainder of the structure are designed to maximise free solar gains. Designing a property to maximise free solar gain need not add to the price of construction.
Studies on houses in Milton Keynes have shown that low cost passive solar design features and draughtproofing and insulating measures reduced heating bills by 40%. Savings paid back the costs in two years. Inclusion of a a conservatory can save up to 20% of annual heating bills although this is strongly dependent on the size of the house, siting, design and materials used. A well designed conservatory acts as extra insulation for the house, preheats the ventilation air and provides direct solar heating to the intervening wall, which is convected into the house, as well as providing additional living space.

Design elements to optimize direct solar gain are:

1. Use thermal storage within the masonry

walls to allow sun to be 'soaked up' during
daylight
hours and released into the building at night
2. Incorporate a responsive, zoned heating system to automatically cut in when and where
necessary.
3. Main glazed areas should face within 30 degrees either side of south.
4. Principal living areas; bedrooms, sitting rooms, those requiring more heat, should have large,
south facing glazing. Infrequently used rooms should be positioned on the north, east and west
sides, with smaller glazed areas.
5. Overshadowing from trees and other buildings should be minimised.
6. The building should be well insulated to minimise heat losses and avoid overheating in summer.
7. Pay close attention to the type of window/glazing used.

For passive solar gains, more heat must flow in than out.

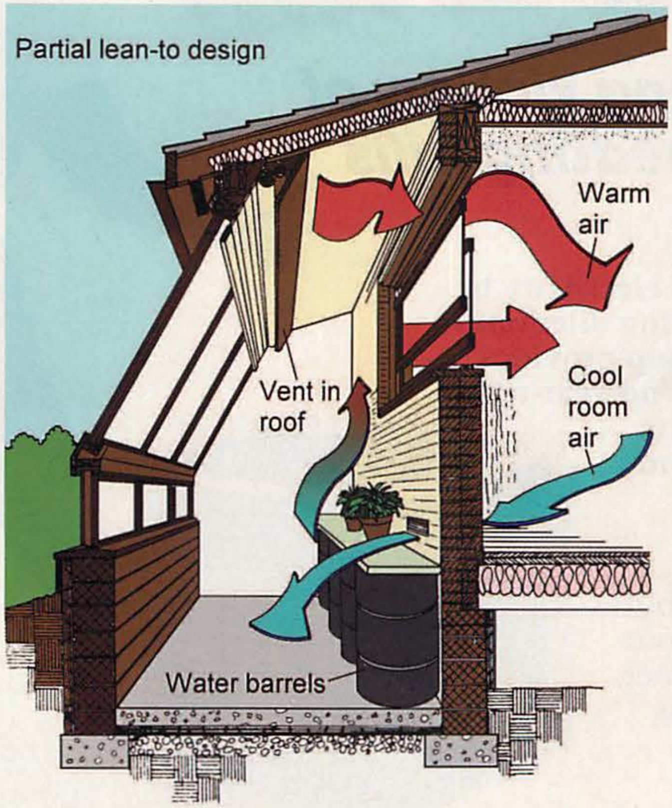
One example of integrated solar design housing is at Skotteparken in Denmark

back

Here Comes the Sun(room)

Building now will provide warmth next winter BY JAMES DULLEY

Can a sunroom be built from scratch? What design is best? Are there any energy-efficient do-it-yourself kits available?



Water barrels will add thermal mass to your sunroom to hold warmth in the room after the sun goes down. Make sure to install the appropriate vents to utilize the warm air to circulate.

If you are a do-it-yourselfer, you should be able to build an efficient sunroom from scratch. And summer is the perfect time to start building before winter dampens your enthusiasm. Adding a sunroom to a house is an excellent investment and often increases the resale value of your home more than its cost. The cost per square foot of floor space is much less than adding a traditional room to your home. Also, it can be a great recreational area for children.

Most fancy sunrooms you see on homes are typically contractor installed, but not all. Contractors buy long (20-feet or more) aluminum framing extrusions and cut them to size at the job site. I did the same, buying 20-foot lengths that I cut myself to build my own sunroom. It took me more than a month to build the addition. I'm told a typical contractor builds one in just two days.

Some sunroom manufacturers will sell the components to homeowners in precut kit sizes. This offers the advantages of lower cost and building the precise size you need. Do an Internet search and contact sunroom manufacturers to see if they sell their products directly in kit form. If you are lucky, you may find a precut kit close to the size you need.

With some do-it-yourself sunroom kits, you simply build the base for the sunroom and assemble the components. Some frames are lightweight enough to be built over a wood deck.

Often, you will find it less expensive to purchase glass or plastic window panes locally. Before you begin to construct the 2-by-4 lumber framing, visit local home centers and building supply outlets. They often have custom-sized high-efficiency windows that a homeowner or builder did not end up buying. Look for ones with low-emissivity glass with argon gas in the gap. These often are sold at a discount. Once you have your windows, design the rest of the sunroom framing to fit them.

In Colorado's average climate, a clear roof captures more heat and you can control any overheating with movable shades. Installing roof vents or a venting skylight also helps. Designs with slanted (lean-to) glass capture the most heat but often have overheating problems.

Also, make the sunroom large enough so you can have a small container garden in one corner for fresh salad greens and herbs year-round. This also produces some moisture for the air, which improves your family's comfort during winter and allows you to set the heating thermostat lower.

For the best comfort and efficiency, add thermal mass to the sunroom. Thermal mass reduces overheating and helps it hold heat when the sun goes down. A brick paver floor and a concrete block knee wall are effective mass. Large planters with heavy clay pots will also provide mass.

Finally, include some provision to get the solar-heated air into your house. The simplest method is to open a window between the house and sunroom when the sunroom is warmer than the house. An exhaust fan (outlet into the house) installed high on a sunroom wall is more effective. For the most convenience, install a thermostat to control the fan.

For your plants and a reasonably comfortable living space, any orientation from southeast to southwest is adequate to capture the sun's heat. Select a convenient location with easy access from inside your house, such as an existing exterior door.

By designing and locating the sunroom properly, it can capture enough free solar heat to stay warm most of the year. It may also help heat the rest of your house during spring and fall so your heat pump or furnace does not have to run as much.

If you plan to use the sunroom to help heat your house, however, an orientation to true solar south is important for the greatest solar heat gain. Depending upon where you live, true solar south varies about 15 degrees from compass south. Check with your local weather service or on the Internet for the amount to adjust compass south to get true solar south for your area.

More questions? Send them to James Dulley, *Colorado Country Life*, 6906 Royalgreen Dr., Cincinnati, OH 45244 or visit www.dulley.com.

Find more energy tips at www.coloradocountrylife.coop.

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A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

NREL National Renewable Energy Laboratory

Innovation for Our Energy Future

A Cold-Climate Case Study for Affordable Zero Energy Homes

The NREL/Habitat for Humanity ZEH in Colorado

Paul Norton and Craig Christensen
National Renewable Energy Laboratory

NREL is operated by Midwest Research Institute • Battelle

Design Criteria

1. Zero net annual source energy
2. Replicable by Habitat
3. Take advantage of volunteer labor
4. Take full material cost into account
5. No special operation of home needed
6. No prototypes: off-the-shelf equipment
7. Keep it simple!

Will it *really* be ZERO??

The Energy *Bills* will NOT be ZERO

- Although natural gas source ENERGY is offset by PV electricity production, net metering pays full price of electricity up to net zero, and only production cost (about $0.02/kWh) for net production – this will not offset natural gas COST
- $15.60 fixed charge per month
  - $6.60 electricity
  - $9.00 natural gas
- Projected annual average energy bill = ~ $30.00/month
(with benchmark occupant behavior and current energy prices)

Some conclusions to date

- The NREL/Habitat ZEH is poised to be an annual net energy producer
- PV system sizing for zero energy homes is challenging
  - Prediction of total home energy use becomes highly uncertain
  - Meeting the ZEH design goal becomes dependent on occupant behavior
  - Economics of excess annual PV production are dependent on net metering agreements
- Zero energy does not necessarily mean zero utility bill
  - Monthly fixed costs for natural gas and electricity service
  - Natural gas costs (Economics of excess annual PV production are dependent on net metering agreements)
- It is possible to make efficient affordable ZEHs with standard construction techniques and off-the-shelf equipment.

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September 22, 2007

News
September 19, 2007

Sunny Outlook: Can Sunshine Provide All U.S. Electricity?

Large amounts of solar-thermal electric supply may become a reality if steam storage technology works—and new transmission infrastructure is built

By David Biello

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In the often cloudless American Southwest, the sun pours more than eight kilowatt-hours* per square meter of its energy onto the landscape. Vast parabolic mirrors in the heart of California's Mojave Desert concentrate this solar energy to heat special oil to around 750 degrees Fahrenheit (400 degrees Celsius). This hot oil transfers its heat to water, vaporizing it, and then that steam turns a turbine to produce electricity. All told, nine such mirror fields, known as

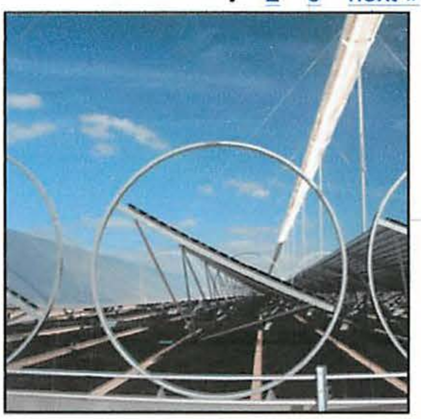

Image: COURTESY OF AUSRA

STEAM AND MIRRORS: A compact linear Fresnel

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concentrating solar power plants, supply 350 megawatts of electricity yearly.

reflector, like Ausra's plant in Australia pictured here, uses lines of mirrors to focus the sun's rays on an overhead trough, turning water into steam to generate electricity.

In the face of mounting concern about climate change, alternatives to coal and natural gas combustion such as these never seemed more attractive. And with the bounty of the sun waiting to be captured near fast-growing major centers of electricity consumption—Las Vegas, Los Angeles and Phoenix, among others—interest in such solar thermal technology is on the rise. The first such plant to be built in decades started providing 64 megawatts of electricity to the neon lights of Vegas this summer.

But physicist David Mills, chief scientific officer and founder of Palo Alto, Calif.–based solar-thermal company Ausra, has bigger ideas: concentrating the sun's power to provide all of the electricity needs of the U.S., including a switch to electric cars feeding off the grid. "Within 18 months, with storage, we will not only reduce [the] cost of [solar-thermal] electricity but also satisfy the requirements for a modern society," Mills claims. "Supplying [electricity] 24 hours a day and effectively replacing the function of coal or gas."

The company insists it can do this at a cost of just 10 cents per kilowatt-hour, analogous to the price of electricity from burning natural gas in California if a cost was imposed for the emission of carbon dioxide, the leading greenhouse gas (as the state's Public Utilities Commission is considering).

Ausra will rely on a different type of concentrating solar power plant to deliver on this promise. French physicist Augustin

U.S. lawmakers in agreement on kids' health bill

Merck halts study of "ineffective" HIV vaccine

Change in CPR may make it more effective

Pain meds may worsen symptoms of enlarged prostate

Diarrhea bacteria lurk quietly in some: report

Hallucinations not unusual with antifungal therapy

Chronic fatigue linked with enterovirus infection

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The Rise of Nanotech

The Early Years

Reality-Bending Black Holes

Fresnel showed in the 19th century that a large lens, like the parabolic troughs of the existing solar-thermal plants, can be broken down into smaller sections that deliver the same focus. Applying this, Mills's design—a compact linear Fresnel reflector—allows for greater ground coverage, lower weight and greater durability than precision-shaped parabolic mirrors. "You can drop stones on it and they bounce off," Mills says. "We would be able to build these in Florida in the hurricane zone."

This Fresnel solar thermal plant also eliminates oil, directly heating water to a lower temperature of roughly 535 degrees F (280 degrees C) at a higher pressure, about 50 bars, or 50 times atmospheric pressure. Then, it uses the resultant steam to turn the same low-temperature turbines as those employed in nuclear reactors.

The amount of electricity produced is simply a function of the sun's bounty and the number of mirrors. "We're moving from 80- to 100-megawatt designs to 700 megawatts and above," says John O'Donnell, Ausra's executive vice president.

The key will be proving performance. Thus far, the company has exactly one solar array, hooked to a coal-fired power plant in Australia to provide extra steam that improves its efficiency at burning the dirty rock. At present, the Ausra mirrors produce just an additional 12 megawatts of extra heat, but there are plans to boost that as high as 38 megawatts thermal.

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SOLAR CONCEPTS

We would like to introduce you to Solar Concepts, Inc., "the complete energy conservation company." We at Solar Concepts realize that everyone's needs differ, therefore we have diversified our solar energy systems to suit a variety of needs. We handle commercial and residential hot water systems, pool heating systems, and an exciting new concept, the SOLAR ASSISTED HEAT PUMP. The company also specializes in passive solar design, solariums,more efficient thermal storage, and window coverings.

In addition to our product line, Solar Concepts offers solar design consultation, solar tax credit consultation, and COMPUTER ANALYSIS of your home or business.

I am sure that you and your family are well aware of our nation's energy problems and do not need to be reminded of the spiraling cost of your fuel bills. The cost of solar water heaters is climbing right along with the price of gas and electricity, and State and Federal tax credits for solar hot water heating won't last forever.

Now is the time to invest in solar water heating. Waiting could cost you valuable dollars!

And what are you waiting for? A dramatic technological .....

BREAKTHROUGH?

Solar water heating has been around much longer than gas or electric water heating. Even before the Spanish American War, there were hundreds of solar water heaters operating in California. When Pasadena's households toasted the 20th century, 30% of them had solar water heaters. One Sunday, radio flashed the news of Pearl Harbor into Florida living rooms. That same day, solar heated water washed the dishes in 60,000 Florida kitchens. In millions of homes around the world today, solar water heaters are as common as refrigerators and stoves.

SOLAR HOT WATER SYSTEMS

Solar Concepts offers the state-of-the-art in high performance, modestly priced collectors. Each one of our well engineered panels includes:

* insulation below and around the side of the absorber plate to minimize heat losses;

* bronzed anodized aluminum frames for lightweight convenience, exceptional durability, and good looks;

* a selective black chrome coating to increase absorptivity and reduce the re-emission of heat from the surface of the absorber plate;

* low iron glass to improve transmission of light through the glazing;

* all systems are designed to do 60-70% of your annual hot water needs;

* a five year complete warranty which covers our installation, including parts, labor, and service;

* Complete Do-It-Yourself kits.

In addition, Solar Concepts was one of the first in the Eugene/Springfield area to be a State Certified Solar Dealer and Installer.

WINTER WARM

Attention Wood Stove Owners:

With the Winter Warm hot water heating system, chopping your own fire wood will warm you twice. Once when you build a fire and again when you take a bath.

Winter Warm is an external heat extractor that uses your wood stove's excess heat to keep your household hot water "piping hot". Used by itself or in line with a solar hot water system, Winter Warm can make a big dent in your rising utility bills. It is easy to install, economical, and incredibly practical.

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SOLAR SPACE HEATING

Space heating with water medium collectors is impractical in the Pacific Northwest. Solar Concepts has found an extremely efficient space heating system for our cloudy climate. The Solar Assisted Heat Pump is ideal in temperate, cloudy locations. The collectors capture heat most efficiently in the sun, yet the system gains heat on cloudy days, in the snow and in the rain.

The Solar Assisted Heat Pump is modular by design, and the collectors are durable, giving many years of reliable service.

The system has been designed to be easily sized for the homeowner's individual heating needs.

This all means an annual savings of 60-70% on both your space heating and hot water needs. Isn't it time you invested in the solar system of the future, that is here today.

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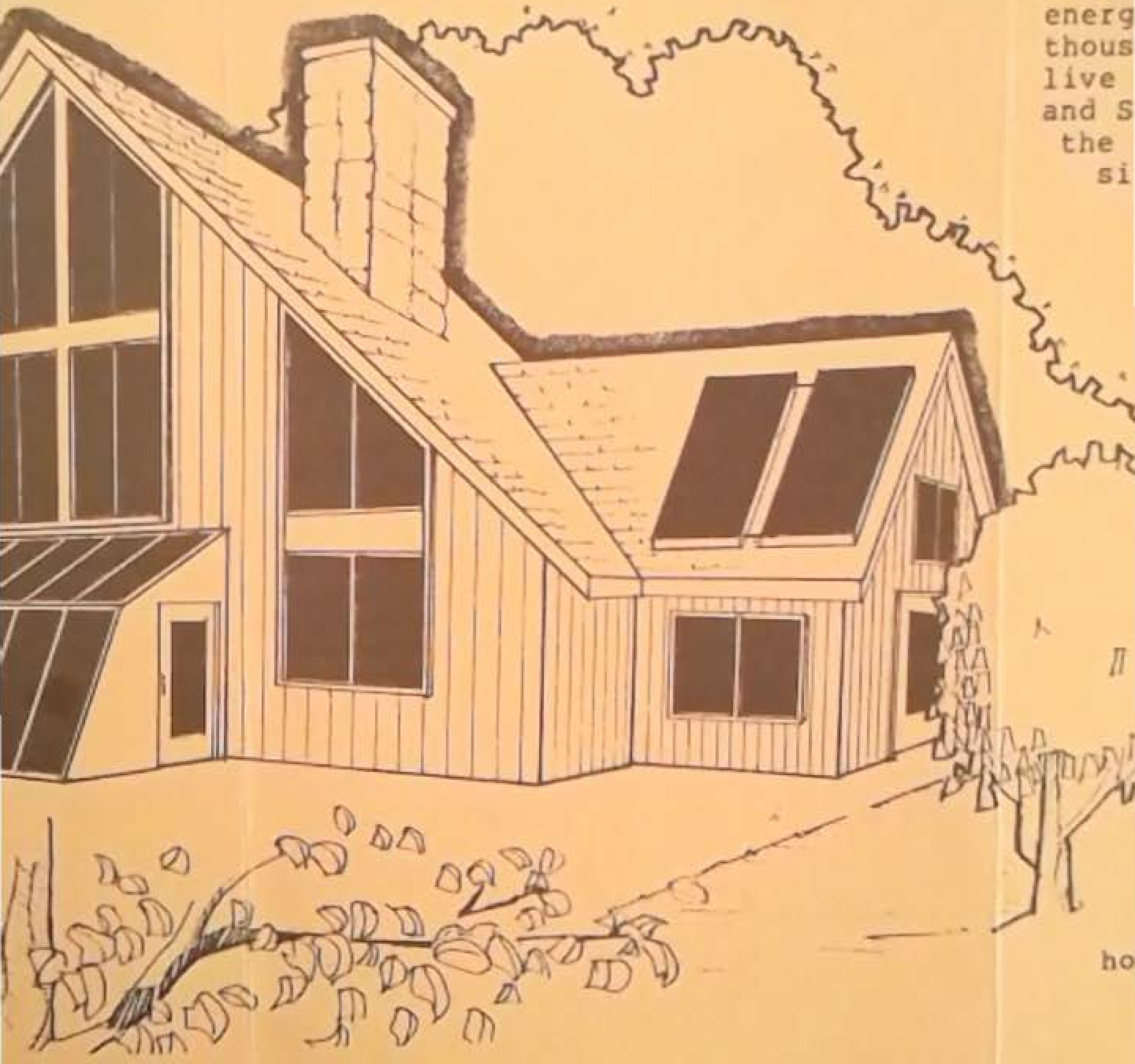
PASSIVE SOLAR SUNSPACES

A solarium is the only room addition you can put on your home that will pay for itself in heat savings and may be elgible for government tax credits.

Solar Concepts carries one of the highest quality and most esthetically



pleasing passive solariums available.

The Sunspace uses the finest quality clear grade cedar in its construction. Cedar has natural insulating qualities and won't sweat.

Sunspace also uses a unique heat sealing tape to completely seal the solarium in an air tight envelope.

All wooden members in a Sunspace are treated with preservative stains to protect and beautify your solarium.

Aluminum caps on the exterior can be added as an option.

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For the Ultimate in quality and beauty, come see our Sunspace kits, or have our designers custom design your solarium addition.

PASSIVE SOLAR DESIGN

Tired of living in a house with high energy bills going higher? Join the thousands of people who have chosen to live in the houses of the future today and SAVE, SAVE, SAVE, while enjoying the light open feeling found in passive solar homes. Let the professional staff at Solar Concepts put you in the finest home in your neighborhood. We can also remodel your existing home with passive solar features.

WINDOW COVERINGS

Did you know that windows are accounting for as much as 50% of the heat loss from your home? Single pane windows have a rating (R-value) of R-1, while thermal panes have an R-2 value. Window Coverings will increase the R-value of your windows to 5. This will cut the heat loss of your window by as much as 79%. In contrast, during the summer, the Window Coverings will keep your house cooler by insulating your home from the hot summer sun. Check it out now!

SWIMMING POOLS

Are you using your pool less often than you would like because the water is too cold? Or, are you missing out on FREE energy by spending a fortune heating your pool during the finest solar heating months of the year? If you are, then let Solar Concepts put you in warmer water longer, for less, with our quality pool systems. If you're not maximizing your pool investment now, we will be glad to show you how.

And its not because they are complicated. It's because they're reliably simple.

If you're looking forward to the next price increase in natural gas and electricity, you won't have long to wait. But you might become bored waiting for the next dramatic breakthrough in solar water heating. The last one occurred 70 years ago. Of course you probably know that. Can it be that what you're really waiting for is a lower .....

PRICE?

If you bought one of the first pocket calculators, you paid $500; $10 for the calculator and $490 for the design. If you bought the millionth calculator, you paid $10. The design cost had already been recovered.

Unlike a pocket calculator, a solar water heater is not "space age technology." You're not paying for an expensive design. You are paying for metal. The millionth solar collector requires the same amount of copper and aluminum as the first. The exploding demand for solar water heaters is increasing the demand for copper and aluminum. As copper and aluminum go up in price, solar water heaters go up in price. Catch 22.

But even that's to your advantage. Your Solar Concepts water heater will appreciate in value every day you own it. Your gas or electric water heater will not.

That's pretty obvious, though. You know that solar water heaters are going up in price, not down. Maybe what you are really worried about is how long your solar water heater will take to return your .....

INVESTMENT?

In other words, how long will it take to "pay for itself?" To answer this, we need a standard for comparison, like your existing hot water heater. How long did it take for your gas or electric water heater to pay for itself? The answer, of course is that it never did. And it never will. Gas and electric water heaters cost money to operate...more & more...every month forever. Even if a solar water heater took 100 years to pay for itself, that would still be better than never.

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But it doesn't take that long. In most cases solar takes only a few years to pay for itself.

Where else can you make 20% annual tax free interest on your investment, or 30%, or more? Certainly not in the bank account where you have your money now!

Solar water heating is for everyone. And the government obviously agrees that a solar water heater is a sound investment right now. Both the State and Federal governments offer healthy tax credit incentives.

<u>State & Federal Tax Credits</u>

Tax Credits are not tax deductions. A tax credit is a dollar for dollar reimbursement from the government for your bottom-line tax liability.

<u>Residential Tax Credits</u>

State	- 25% up to	$1000 Maximum
Federal	- <u>40%</u> up to	<u>$4000</u> Maximum
Total	- 65%	$5000

For example, a residential hot water system for a family of four, normally costing $4000, would have $2600 in tax credits and a realized net investment of $1400.

<u>Commercial Tax Credits</u>

State	- 35%	no limit	
Federal	- 15%	no limit	(ENERGY)
	<u>10%</u>	no limit	(INVESTMENT)
Total	- 60%	no limit	

* Including a (5) year accelerated depreciation.

The monthly savings enjoyed by you are not taxable, yet give you increased disposable income.

The system will last the life time of your home with some maintenance. It will hold its own or increase in value along with your home.

The State of Oregon will not assess additional property taxes on the increased value of your home due to a solar installation until 1995.

Let the professionals at Solar Concepts show you the way to save energy and make a wise financial investment.

CAN YOU AFFORD NOT TO OWN A SOLAR SYSTEM FROM SOLAR CONCEPTS, INC.?

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CONCEPTS, INC.?

The economy of any solar system is dependent on the efficient performance of the total system. The best components in the world will not operate efficiently if they are incorrectly installed or designed for your particular solar application. We recommend that you, the prospective solar system owner, compare the quality and workmanship of other solar products and dealers. We feel confident that you will prefer the professional knowledge and the quality products and workmanship found within our company, **Solar Concepts, Inc.**

Thank you very much!

Apartments
Appliances & Electronics
Designing & Remodeling
Electricity
Energy Audits
Insulation & Air Sealing
Landscaping
Lighting & Daylighting
Space Heating & Cooling
Water Heating
Water Heater Selection
- Costs
- Energy Efficiency
- Fuels
- Sizing
- Demand Water Heaters
- Heat Pump Water Heaters
- Solar Water Heaters
- Storage Water Heaters
- Tankless Coil & Indirect Water Heaters
Energy-Efficient Water Heating
Swimming Pool Heating
Windows, Doors & Skylights

Printable Version

Sizing a Solar Water Heating System

Sizing your solar water heating system basically involves determining the total collector area and the storage volume you'll need to meet 90%–100% of your household's hot water needs during the summer. Solar system contractors use worksheets and computer programs to help determine system requirements and collector sizing.

Collector Area

Contractors usually follow a guideline of around 20 square feet (2 square meters) of collector area for each of the first two family members. For every additional person, add 8 square feet (0.7 square meters) if you live in the U.S. Sun Belt area or 12–14 square feet if you live in the

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Florida Solar Energy Center

Solar Water Heating System Installation Guidelines
Solar Rating and Certification Corporation

Reading List
Related Publications

northern United States.

Storage Volume

A small (50- to 60-gallon) storage tank is usually sufficient for one to two three people. A medium (80-gallon) storage tank works well for three to four people. A large tank is appropriate for four to six people.

For active systems, the size of the solar storage tank increases with the size of the collector—typically 1.5 gallons per square foot of collector. This helps prevent the system from overheating when the demand for hot water is low. In very warm, sunny climates, some experts suggest that the ratio should be increased to as much as 2 gallons of storage to 1 square foot of collector area.

Other Calculations

Additional calculations involved in sizing your solar water heating system will include the following:

- Evaluation of your building site's solar resource
- Orientation and tilt of the

solar collector.

Related Information

- Solar water heaters
- Reduce Your Hot Water Use for Energy Savings

Printable Version

Content Last Updated: September 12, 2005

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Solar Advisor Model

The current version of the Solar Advisor Model (SAM) is Version 1.3, p
17, 2007. For SAM's version history, please download the *Release Note*
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provide your name and a valid email address. To update an older versi
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This version replaces all previous versions of the software and address
identified by the SAM development team.

SAM includes a user guide that you can access on the software's Help

SAM must be installed on a computer running Windows XP or 2000 wit
MB of free disk space. Please note that the Windows regional options n
English (United States).

For more information about SAM, download the *SAM User Guide* (PDF
Download Adobe Reader

For questions and issues not addressed by the *SAM User Guide*, please
to Solar_Advisor_Support@nrel.gov.

Printable Version

Shedding Some Light on Solar Cells

Both the technology and materials stand within our reach

by josef velten
jav072000@utdallas.edu

There was an article this past September that addressed green energy and solar cells in specific. It painted a rather bleak picture about solar cells and asserted that the energy cost to manufacture them is greater than the amount of power that they produce, resulting in a net energy loss.

I am here to say (with some authority) that this is not the case. Solar cells and solar energy right now can be constructed with a net energy gain. The earlier article suffered from a lack of good research and background reading to gain familiarity with the subject.

Solar powered sterling engines are already being constructed in California. Those "huge fields of mirrors" are actually quite movable and can be programmed to turn with the sun for maximum efficiency and with little effort using a pair of low powered motors.

As of 2005, energy provider Southern California Edison made a 20-year agreement to build a 500-megawatt power plant using mirrors and steam engines. Quoted average efficiency is roughly 25%. For comparison, an 11 by 11 mile complex could produce more energy than the Hoover dam. A 100 by 100 mile complex (about 3 times the size of Yellowstone national park) of this efficiency could produce roughly the entire daytime energy demands of the U.S., the largest consumer of electrical energy in the world.

I'm perfectly willing to admit that this field would have to be in Nevada, Arizona, New Mexico or the southeastern California, but the sites are available, and arguably this land is not exactly in the highest of demand. As anecdotal proof, I can remember taking a trip to New Mexico that advertised the next hotel 250 miles away. We are certainly not talking about the most densely populated region of the U.S.

The article brings up another flawed argument about solar power from silicon chips. There is not one single way to make a solar cell. The quoted 40% efficiency solar panels are specifically single crystal, multi junction solar cells used almost exclusively for puttering around in the lab and for times when carrying around fuel or laying power lines to distant locations is a bad proposition.

For example, these more expensive silicon chips are used in space stations, space shuttles, and remote regions in the world where population density is low but electricity is needed.

Not all silicon solar cells are equally efficient or identical in the processing energy required. Silicon solar cells can also be made from thin films of amorphous silicon that require much less processing and can give an output of around 10-15%. These cells are produced with less energy than they will take in during their operational lifetimes.

Solar cells are also not restricted to being made only out of silicon. CIGS solar cells are made from copper, indium, gallium and selenium and are essentially inkjet printed onto glass. Efficiencies of roughly 10%-15% can be found here, and the solar cells are so thin, measured in micron thickness, that there is very little use of materials in a given square meter of solar cell.

If you would like to know more, there is a local company, based out of Austin, TX, named HelioVolt that is making these CIGS to be integrated into building materials, such as the windows and roofing material of a building. This method of integrating solar panels into buildings is called (rather unimaginatively) Building Integrated Photovoltaics (BIPV) and promises to cut down on the main complaint of solar cells for every day use: their unsightliness.

Research is being done right here at UTD on Dye Sensitized Solar Cells (DSC). The operating principle behind DSC is that they very closely mimic the method that plants used to harvest sunlight and make energy stored in sugars. Instead of storing the energy as sugars, however, we make electricity. This type of solar cell uses relatively cheap materials, like titanium dioxide, an ore that takes minimal processing.

> "Despite some claims, solar cells and solar energy right now can be constructed with a net energy gain... these cells are also not restricted to being made only of silicon."

It's so cheap that it's currently used as a pigment in paint or toothpaste (if you have ever wondered what makes white paint white, well, titanium dioxide is the most likely culprit). The other components to making this type of solar cell are Iodine, a specialized dye, a solvent to dissolve the Iodine, and a counterelectrode.

With these relatively simple ingredients it takes very little effort to make solar cells that have 10-15% efficiency. The only drawback is that their operational lifetime has only been confirmed to last around a decade; however research is progressing to increase the lifespan of this type of solar cell.

The point I am trying to make about solar cells is this: while not as easy an energy source as the prepackaged sources of energy that are fossil fuels, electrical energy can be produced using solar energy, at a net gain of energy. ■

Josef's 100-megawatt smile has powered the hearts of a thousand ladies. Efficiently.
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Do You Want to Know More?

http://www. solaronix.ch
Click on the "technologies" tab for an in-depth review on dye-sensitized solar cells.

http://www.nanosolar.com
Click on "Technology" for an explanation of CIGS.

http://en.wikipedia.org/wiki/solar_cells
Leave it to Wikipedia to supply you with decent material on the topic.

Or, best of all, ask one of us working in the labs here about what's going on.

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file- p18 Robertson
Hder Solar .pdf
10/11/07, 22 pages

UTILITY DRIVEN SOLAR ENERGY AS A LEAST-COST STRATEGY TO MEET RPS POLICY GOALS AND OPEN NEW MARKETS

Chris Robertson and Jill K Cliburn
ElectricSUN

American Solar Energy Society
SOLAR 2006

ElectricSUN
The Electric Solar Utility Network

DRYDEN NEWS

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Jan. 19, 2005

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RELEASE: 05-01

Solar Array Demonstrates Commercial Potential at NASA Dryden

A state-of-the-art solar array is providing a unique opportunity to demonstrate the latest in high-efficiency solar cells available for terrestrial use at a demonstration site at NASA's Dryden Flight Research Center at Edwards Air Force Base, Calif.

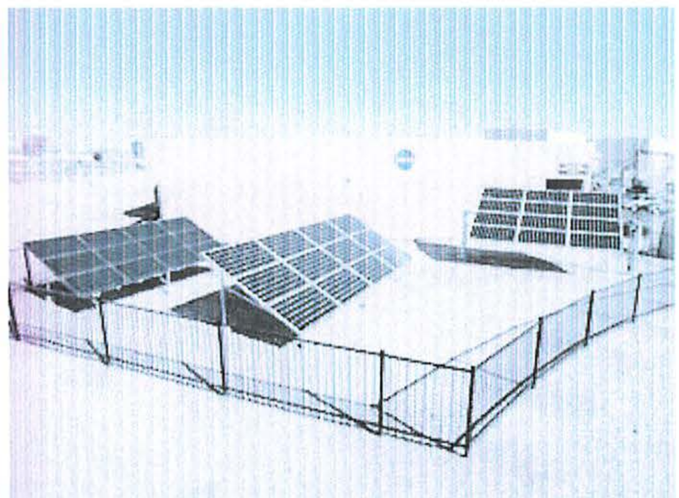

Image Right: The 5 KW, state-of-the-art solar demonstration site at NASA Dryden is validating earthly use of solar cells developed for NASA's Helios solar-electric aircraft. NASA Photo by Tom Tschida

Manufactured by SunPower Corporation of Sunnyvale, Calif., the A-300 silicon cells were derived from those developed for the NASA / AeroVironment Helios and Pathfinder-Plus solar-powered aircraft under the now-concluded Environmental Research Aircraft and Sensor Technology (ERAST) program. They are considered to be the most advanced photo-voltaic cells available for terrestrial applications.

The experimental site consists of two fixed-angle solar arrays and one single-axis sun-tracking array. Together they produce up to five kilowatts of direct current power on a sunny day, which is equivalent to powering two or three average California homes. The sun-tracking array tilts to follow the sun using an advanced "real-time" tracking device rather than normal pre-programmed mechanisms. One of the fixed arrays contains standard less-efficient cells, and is being used as a baseline comparison for the newer fixed-cell array. According to SunPower, typical commercial-grade solar cells are in the range of 12 to15 percent efficient at converting sunlight to electricity, while the new cells are 20 percent efficient, or up to 50 percent better than the older technology.

The efficiency improvement is due largely to the routing of cell electrical connections behind the cells, which was required in the original design for the solar-powered aircraft to maximize the limited space available atop the wings.

"It is a grid-connected system, so it is putting power back into the electrical grid," stated Jon Ferrall, NASA Dryden electrical engineer, who managed the installation of the solar array demonstration site. "The system is providing significant power to the 7,870 square foot Public Affairs and Commercialization building here at Dryden."

The demonstration is comparing the potential advantage of the tracking array over the fixed array, verifying the effectiveness of the dirt-repellant coating over the protective glass housing the solar cells, and the effect, if any, of dust and dirt on the arrays. Array efficiency is monitored remotely on a computer.

Should the demonstration be successful, it would be a major step toward transferring the technology to the commercial market, allowing for mass production of these high-efficiency solar cells for a variety of residential, business and governmental applications.

Charlie Gay, chief array installer of SunPower, said they have been able to actively predict the output of the system.

"SunPower's ability to predict energy delivery over the span of the past year is attributed to the modules and system working well," Gay said.

Jennifer Baer-Riedhart, NASA Dryden's project manager for the solar demonstration site, estimated that the life expectancy is at least 25 years.

A second phase of the demonstration will consist of establishing an Internet web site that will allow the public to view "real-time" information on the Dryden solar demonstration site, as well as other solar array sites that are planned for construction in Hawaii and Arizona.

Long-term plans include construction of a solar "farm" at NASA Dryden that would power up to one-third of the center's electrical power needs.

The solar power demonstration site was funded through a technology commercialization allocation from NASA's ERAST program at a cost of around $130,000. It was constructed by Renewable Energy Concepts Inc. of Los Osos, Calif.

- NASA -

NOTE TO EDITORS: A publication-quality photo to support this release is available on the NASA Dryden Internet web site photo gallery by pasting the following URL into your browser:
http://www.dfrc.nasa.gov/Gallery/Photo/Places/HTML/EC03-0283-20.html

- end -

text-only version of this release

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Editor: Marty Curry
NASA Official: Brian Dunbar
Last Updated: October 27, 2007

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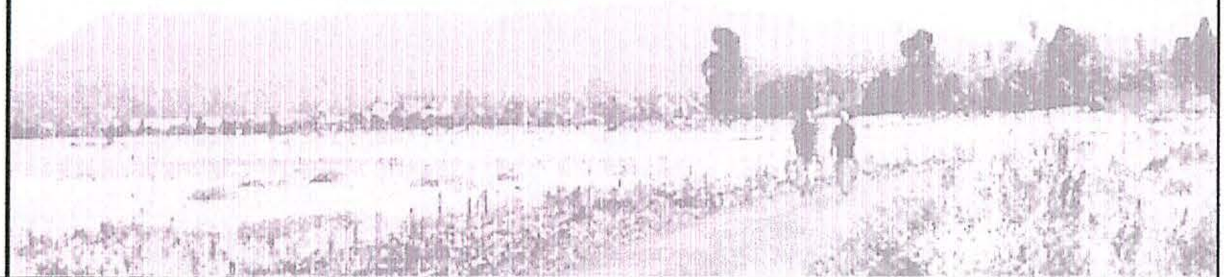

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FOR IMMEDIATE RELEASE

September 29, 2006
Contact: Barry Martin, 707-258-7843 bmartin@cityofnapa.org

City of Napa Dedicates Solar Power System at Lake Hennessey Pump Station

PowerLight PowerTracker® Deployed to Help Napa Meet Its Electricity Needs With Clean, On-site Solar Power Generation

Today the City of Napa dedicated a major City-owned solar power system at its Lake Hennessey Pump Station. The 356kW solar power system was designed and deployed by PowerLight Corporation. At over a third of a megawatt, this solar power system is one of the largest municipal solar power systems in Northern California.

"Napa is very pleased to be harnessing the wine country's abundant sunshine by deploying solar power. Clean, emissions-free, on-site solar generation enables us to be responsible stewards of our region — improving our community's health and quality of life," said Phil Brun of the City of Napa's Public Works Department.

The City of Napa commissioned a solar power tracking system, PowerLight

PowerTracker®, to meet a portion of its electricity needs in a clean, sustainable manner.

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It makes use of an underutilized asset —the grounds adjacent to the pump station— to generate electricity that is clean, silent, and emissions-free. The PowerTracker solar power system features an innovative single-axis design enabling solar panels to follow the path of the sun automatically throughout the day to maximize the panels' energy generation.

"By generating solar power, Napa is reducing demand from the utility grid, lowering operating costs, and improving air quality for its community," said PowerLight executive vice president Howard Wenger. "By effectively reducing its purchases of expensive peak electricity, Napa is doing its part to address California's ongoing energy challenges. This energy solution saves money while helping the environment."

The City of Napa anticipates average savings exceeding $100,000 annually in avoided electricity purchases, with an estimated total electricity bill savings of $3.2 million over the next 25 years. Additionally, Napa's solar power generation spares the environment from tons of harmful emissions, such as nitrogen oxides, sulfur dioxide, and carbon dioxide, which are major contributors to smog, acid rain, and global warming. Over the expected 30-year lifetime of the system, the combined solar-generated electricity will reduce emissions of carbon dioxide by 4,200 tons. These emissions reductions are the equivalent to planting 1,170 acres of trees, removing almost 855 cars, or not driving 10.5 million miles on California's roadways.

About the City of Napa
Located in the heart of California's celebrated wine country, the City of Napa is the county seat of Napa County. Established in 1850, it is named after the Napa Indians who once inhabited the area. Napa is known for its magnificent vineyards and outstanding wine, and other agricultural products. The City of Napa has a longstanding commitment to preserving the region's environment and aesthetic natural beauty. The City's mission is to preserve and promote the unique quality of life that is Napa, with its scenic vistas and rich cultural heritage. In keeping with its efforts to reduce fossil fuel emissions and incorporate clean, reliable renewable technologies into Napa's energy portfolio, the City contracted with PowerLight to design and deploy a significant new solar power tracking installation at its Lake Hennessey Pump Station.

About PowerLight
PowerLight Corporation is a leading global provider of large-scale solar power systems, delivering unmatched experience and proven financial performance to commercial, utility, public sector, and residential customers. PowerLight's industry-leading products, technologies and services enable our customers to maximize clean energy output along with project savings. Today, PowerLight designs, deploys, and operates the largest solar power systems in the world through market-leading innovation and exceptional customer service. For more information, please visit www.powerlight.com.
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U.S. Department of Energy - Energy Efficiency and Renewable Energy
Tribal Energy Program – Guide to Tribal Energy Development

Solar Cells and Photovoltaic Arrays

Solar cells convert sunlight directly into electricity and are made of semiconducting materials similar to those used in computer chips. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting light (photons) to electricity (voltage) is called the photovoltaic effect. A typical solar cell measures 10 centimeters by 10 centimeters (about 4 inches square) and generates about 1 Watt of power at about 0.5 volts.

A typical solar cell

Individual solar cells can be connected in series in order to increase the voltage, or in parallel in order to increase the current into a module. Solar cells are typically combined into modules that hold about 40 cells, and about 10 of these modules are mounted in a photovoltaic (PV) array that can measure up to several meters on a side. These PV arrays can be mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture the most sunlight over the course of a day. About 10 to 20 PV arrays can provide enough power for a typical U.S. household, although some tribal residences may use less power. PV arrays can also be used for large electric utility or industrial applications. Hundreds of arrays can be interconnected to form a single, large PV system.

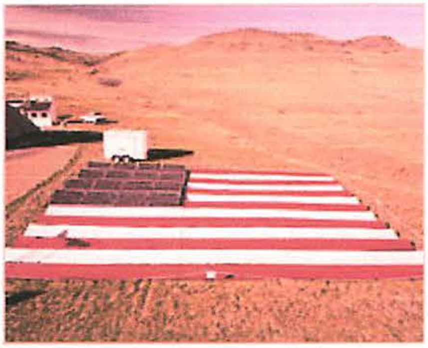
Installing a PV array on a building

PV systems have few moving parts and are highly reliable. In fact, many PV arrays come with warranties that are good for 20 years or more. Flat-plate PV arrays without tracking have no moving parts, and even two-axis tracking requires only a relatively small number of low-speed moving parts. This tends to keep operation and maintenance (O&M) costs down. Indeed, some early kilowatt-scale first-of-a-kind plants demonstrated O&M costs around half a cent per kilowatt-hour, which is minimal.

In many PV systems, energy will not be used as it is produced but may be required at night or on cloudy days. If tapping into the utility grid is not an option, a battery backup system will be necessary. About 80% of the energy channeled into the battery backup can be reclaimed. Like PV cells, batteries are direct-current devices and are directly compatible only with dc loads. However, batteries can also serve as a power conditioner for these loads by regulating power; this allows the PV array to operate closer to its optimum power output. Most batteries must also be protected from overcharge and excessive discharge, which can cause electrolyte loss and can even damage or ruin the battery plates. Protection is usually achieved using a charge controller, which also maintains system voltage. Most charge controllers also have a mechanism that prevents current from flowing from the battery back into the array at night.

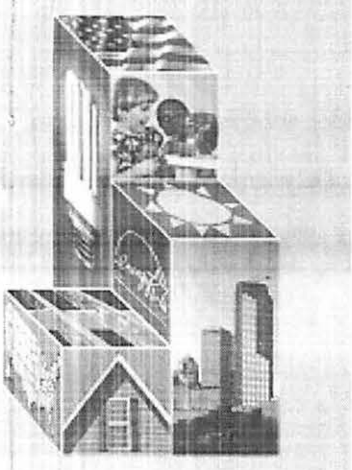
Content Last Updated: 06/18/2007

PV Systems with Battery Storage



This 4-kilowatt solar electric system, dubbed "Solar Independence," is the largest mobile power unit ever built. The flag's field of blue consists of photovoltaic panels made of silicon; these panels generate enough electricity to provide power to one or two homes. Workhorse batteries that can store up to 51 kilowatt-hours of electricity are in a portable trailer behind the flag. This system has been part of several emergency training exercises in Colorado and has been exhibited on the National Mall in Washington, D.C.

PV systems with batteries for storage are excellent for supplying electricity when and where you need it. These systems are especially suitable in areas where utility power is unavailable or utility line extensions would be too expensive. The ability to store PV-generated electrical energy makes the PV system a reliable source of electric power both day and night, rain or shine. PV systems with battery storage are used all over the world to provide electricity for lights, sensors, recording equipment, switches, appliances, telephones, televisions, and even power tools!



PASSIVE SOLAR DESIGN

Increase energy efficiency and comfort in homes by incorporating passive solar design features

Buildings for the 21st Century

Buildings that are more energy efficient, comfortable, and affordable...that's the goal of DOE's Office of Building Technology, State and Community Programs (BTS). To accelerate the development and wide application of energy efficiency measures, BTS:

- Conducts R&D on technologies and concepts for energy efficiency, working closely with the building industry and with manufacturers of materials, equipment, and appliances
- Promotes energy/money saving opportunities to both builders and buyers of homes and commercial buildings
- Works with state and local regulatory groups to improve building codes, appliance standards, and guidelines for efficient energy use
- Provides support and grants to states and communities for deployment of energy-efficient technologies and practices

DESIGN WITH THE SUN IN MIND

Sunlight can provide ample heat, light, and shade and induce summertime ventilation into the well-designed home. Passive solar design can reduce heating and cooling energy bills, increase spatial vitality, and improve comfort. Inherently flexible passive solar design principles typically accrue energy benefits with low maintenance risks over the life of the building.

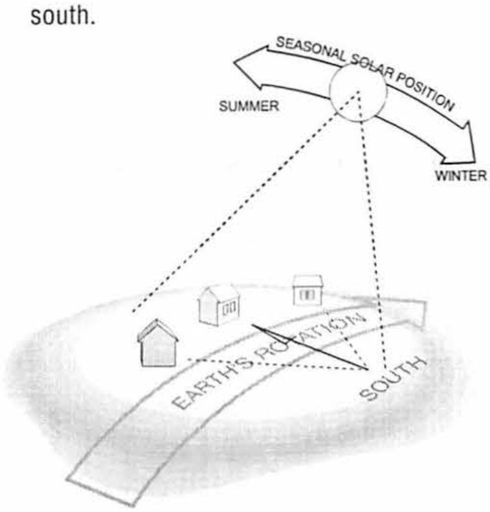
DESIGN TECHNIQUES

Passive solar design integrates a combination of building features to reduce or even eliminate the need for mechanical cooling and heating and daytime artificial lighting. Designers and builders pay particular attention to the sun to minimize heating and cooling needs. The design does not need to be complex, but it does involve knowledge of solar geometry, window technology, and local climate. Given the proper building site, virtually any type of architecture can integrate passive solar design.

Passive solar heating techniques generally fall into one of three categories: *direct gain*, *indirect gain*, and *isolated gain*. Direct gain is solar radiation that directly penetrates and is stored in the living space. Indirect gain collects, stores, and distributes solar radiation using some thermal storage material (e.g., Trombé wall). Conduction, radiation, or convection then transfers the energy indoors. Isolated gain systems (e.g., sunspace) collect solar radiation in an area that can be selectively closed off or opened to the rest of the house.

Passive solar design is not new. In fact, ancient civilizations used passive solar design. What is new are building materials, methods, and software that can improve the design and integration of passive solar principles into modern residential structures.

SOLAR POSITIONING CONSIDERATIONS
The south side of the home must be oriented to within 30 degrees of due south.



COST

It takes more thought to design with the sun; however, passive solar features such as additional glazing, added thermal mass, larger roof overhangs, or other shading features can pay for themselves. Since passive solar designs require substantially less mechanical heating and cooling capacity, savings can accrue from reduced unit size, installation, operation, and maintenance costs. Passive solar design techniques may therefore have a higher first cost but are often less expensive when the lower annual energy and maintenance costs are factored in over the life of the building.

Publications

NREL develops publications, including technical reports and papers, about its R&D activities in concentrating solar power, as well as related information. Below you'll find a list of selected NREL publications concerning these activities.

For other NREL concentrating solar power publications, you can search NREL's Publications Database.

Selected Publications

These publications are available as Adobe Acrobat PDFs. Download Adobe Reader.

Stoddard, L.; Abiecunas, J.; O'Connell, R. ***Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California*** (PDF 1.5 MB). NREL/SR-550-39291. Golden, CO: National Renewable Energy Laboratory, April 2006. 69 pp.

Schwer, R.K.; Riddel, M. ***The Potential Economic Impact of Constructing and Operating Solar Power Generation Facilities in Nevada*** (PDF 948 KB). NREL/SR-550-35037. Golden, CO: National Renewable Energy Laboratory, February 2004. 28 pp.

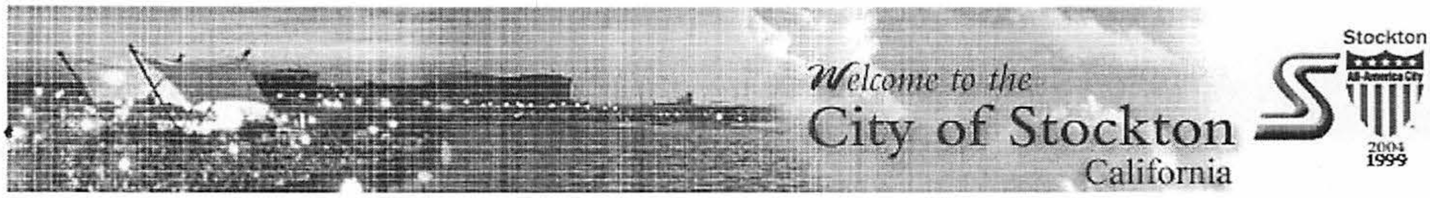
Sargent & Lundy LLC Consulting Group. ***Executive Summary: Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts*** (PDF 588 KB). NREL/SR-550-34440. Golden, CO: National Renewable Energy Laboratory, October 2003. 47 pp.

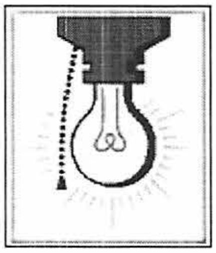
Sargent & Lundy LLC Consulting Group. ***Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts*** (PDF 2.42 MB). NREL/SR-550-34440. Golden, CO: National Renewable Energy Laboratory, October 2003. 344 pp.

Assessing the Potential for Renewable Energy on Public Lands (PDF 4.53 MB). DOE/GO-102003-1704. Golden, CO: National Renewable Energy Laboratory, February 2003. 95 pp.

Leitner, A.; Owens, B. ***Brighter than a Hundred Suns: Solar Power for the Southwest*** (PDF 809 KB). NREL/SR-550-33233. Work performed by Platts Research and Consulting, Boulder, CO. Golden, CO: National Renewable Energy Laboratory, January 2003. 28 pp.

Leitner, A. ***Fuel from the Sky: Solar Power's Potential for Western Energy Supply*** (PDF 2.94 MB). NREL/SR-550-32160. Golden, CO: National Renewable Energy Laboratory, July 2002. 180 pp.





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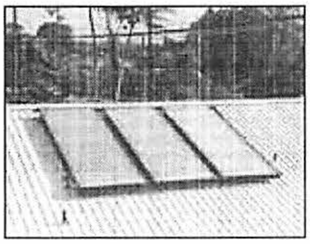

Solar collectors are the heart of most solar energy systems. The collector absorbs the sun's light energy and changes it into heat energy. Solar collectors heat a fluid, either air or liquid. This fluid then is used to heat—directly or indirectly—the following.

- Water for household use.
- Indoor spaces
- Water for swimming pools
- Water or air for commercial use
- Air to regenerate desiccant (drying) material in a desiccant cooling system.

There are several types of solar collectors used for residences. These are flat-plate, evacuated-tube, and concentrating collectors.

Flat-Plate Collectors

Flat-plate collectors are the most common collector for residential water-heating and space-heating installations. A typical flat-plate collector is an insulated metal box with a glass or plastic cover—called the glazing—and a dark-colored absorber plate. The glazing can be transparent or translucent. Translucent (transmitting light only), low-iron glass is a common glazing material for flat-plate collectors because low-iron glass transmits a high percentage of the total available solar energy. The glazing allows the light to strike the absorber plate but reduces the amount of heat that can escape. The sides and bottom of the collector are usually insulated, further minimizing heat loss.

The absorber plate is usually black because dark colors absorb more solar energy than light colors. Sunlight passes through the glazing and strikes the absorber plate, which heats up, changing solar radiation into heat energy. The heat is transferred to the air or liquid passing through the collector. Absorber plates are commonly covered with "selective coatings," which retain the absorbed sunlight better and are more durable than ordinary black paint.

Absorber plates are often made of metal- usually copper or aluminum—because they are both good heat conductors. Copper is more expensive, but is a better conductor and is less prone to corrosion than aluminum.

Flat-plate collectors fall into two basic categories: liquid and air. And both types can be either glazed or unglazed.

Liquid Collectors

In a liquid collector, solar energy heats a liquid as it flows through tubes in or adjacent to the absorber plate. For this type of collector, the flow tubes are attached to the absorber plate so the heat absorbed by the absorber plate is readily conducted to the liquid.

The flow tubes can be routed in parallel, using inlet and outlet headers, or in a

Pump Efficiency
Greenhouse Costs

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serpentine pattern. A serpentine pattern eliminates the possibility of header leaks and ensures uniform flow. A serpentine pattern is not appropriate, however, for systems that must drain for freeze protection because the curved flow passages will not drain completely.

The simplest liquid systems use potable household water, which is heated as it passes directly through the collector and then flows to the house to be used for bathing, laundry, etc. This design is known as an "open-loop" (or "direct") system. In areas where freezing temperatures are common, however, liquid collectors must either drain the water when the temperature drops or use an antifreeze type of heat-transfer fluid.

In systems with heat-transfer fluids, the transfer fluid absorbs heat from the collector and then passes through a heat exchanger. The heat exchanger, which generally is in the water storage tank inside the house, transfers heat to the water. Such designs are called "closed-loop" (or "indirect") systems.

Glazed liquid collectors are used for heating household water and sometimes for space heating. Unglazed liquid collectors are commonly used to heat water for swimming pools. Because these collectors need not withstand high temperatures, they can use less expensive materials such as plastic or rubber. They also do not require freeze-proofing because swimming pools are generally used only in warm weather.

Air Collectors

Air collectors are simple, flat-plate collectors used primarily for space heating. The absorber plates in air collectors can be metal sheets, layers of screen, or non-metallic materials. The air flows past the absorber by natural convection or when forced by a fan. Because air conducts heat much less readily than liquid does, less heat is transferred between the air and the absorber than in a liquid collector.

In some solar air-heating systems, fins or corrugations on the absorber are used to increase air turbulence and improve heat transfer. The disadvantage of this strategy is that it can also increase the amount of power needed for fans and, thus, increase the costs of operating the system. In colder climates, the air is routed between the absorber plate and the back insulation to reduce heat loss through the glazing. However, if the air will not be heated more than 30°F (17°C) above the outdoor temperature, the air can flow on both sides of the absorber plate without sacrificing efficiency.

Air systems have the advantage of eliminating the freezing and boiling problems associated with liquid systems. Although leaks are harder to detect and plug in an air system, they are also less troublesome than leaks in a liquid system. Air systems can often use less-expensive materials, such as plastic glazing, because their operating temperatures are usually lower than those of liquid collectors.

Evacuated-Tube Collectors

Evacuated-tube collectors heat water in residential applications that require higher temperatures. In an evacuated-tube collector, sunlight enters through the outer glass tube, strikes the absorber tube, and changes to heat. The heat is transferred to the liquid flowing through the absorber tube. The collector consists of rows of parallel transparent glass tubes, each of which contains an absorber tube (in place of the absorber plate in a flat-plate collector) covered with a selective coating. Evacuated-tube collectors are modular—tubes can be added or removed as hot-water needs change.

When evacuated tubes are manufactured, air is evacuated from the space between the two tubes, forming a vacuum. Conductive and convective heat losses are eliminated because there is no air to conduct heat or to circulate and cause convective losses. There can still be some radiant heat loss (heat energy will move through space from a warmer to a cooler surface, even across a vacuum). However, this loss is small and of little consequence compared with the amount of heat transferred to the liquid in the absorber tube.

Evacuated-tube collectors are available in a number of designs. Some use a third glass tube inside the absorber tube or other configurations of heat-transfer fins and fluid tubes. One commercially available evacuated-tube collector stores 5 gallons

(19 liters) of water in each tube, eliminating the need for a separate solar storage tank. Reflectors placed behind the evacuated tubes can help to focus additional sunlight on the collector.
These collectors are more efficient than flat-plate collectors for a couple of reasons. First, they perform well in both direct and diffuse solar radiation. This characteristic, combined with the fact that the vacuum minimizes heat losses to the outdoors, makes these collectors particularly useful in areas with cold, cloudy winters. Second, because of the circular shape of the evacuated tube, sunlight is perpendicular to the absorber for most of the day. For comparison, in a flat-plate collector that is in a fixed position, the sun is only perpendicular to the collector at noon. While evacuated-tube collectors achieve both higher temperatures and higher efficiencies than flat-plate collectors, they are also more expensive.

Concentrating Collectors

Concentrating collectors use mirrored surfaces to concentrate the sun's energy on an absorber called a receiver. Concentrating collectors also achieve high temperatures, but unlike evacuated-tube collectors, they can do so only when direct sunlight is available. The mirrored surface focuses sunlight collected over a large area onto a smaller absorber area to achieve high temperatures. Some designs concentrate solar energy onto a focal point, while others concentrate the sun's rays along a thin line called the focal line. The receiver is located at the focal point or along the focal line. A heat-transfer fluid flows through the receiver and absorbs heat.
These collectors reach much higher temperatures than flat-plate collectors. However, concentrators can only focus direct solar radiation, with the result being that their performance is poor on hazy or cloudy days. Concentrators are most practical in areas of high insolation (exposure to the sun's rays), such as those close to the equator and in the desert southwest United States.
Concentrators perform best when pointed directly at the sun. To do this, these systems use tracking mechanisms to move the collectors during the day to keep them focused on the sun. Single-axis trackers move east to west; dual-axis trackers move east and west and north and south (to follow the sun throughout the year). In addition to these mechanical trackers, there are passive trackers that use freon to supply the movement. While not widely used, they do provide a low-maintenance alternative to mechanical systems.
Concentrators are used mostly in commercial applications because they are expensive and because the trackers need frequent maintenance. Some residential solar energy systems use parabolic-trough concentrating systems. These installations can provide hot water, space heating, and water purification. Most residential systems use single-axis trackers, which are less expensive and simpler than dual-axis trackers.

Technological Improvements

The efficiency of solar heating systems and collectors has improved from the early 1970s and costs have dropped somewhat. The efficiencies can be attributed to the use of low-iron, tempered glass for glazing (low-iron glass allows the transmission of more solar energy than conventional glass), improved insulation, and the development of durable selective coatings.
Also, a new solar air collector, formerly used primarily for commercial buildings, is now available for homes. Called a transpired collector, it eliminates the cost of the glazing, the metal box, and the insulation. This collector is made of black, perforated metal. The sun heats the metal, and a fan pulls air through the holes in the metal, which heats the air. For residential installations, these collectors are available in 8-foot by 2.5-foot (2.4-meter by 0.8-meter) panels capable of heating 40 cubic feet per minute (0.002 cubic meters per second) of outside air. On a sunny winter day, the panel can produce temperatures up to 50°F (28°C) higher than the outdoor air temperature. Transpired air collectors not only heat air, but also improve indoor air quality by directly preheating fresh outdoor air.
These collectors have achieved very high efficiencies—more than 70% in some

commercial applications. Plus, because the collectors require no glazing or insulation, they are inexpensive to manufacture. All these factors make transpired air collectors a very cost-effective source of solar heat.
There are other prototype cooling systems operating today. Some use heat from solar collectors for absorption cooling. Others are being used to renew the desiccant material in desiccant cooling systems. Desiccants, such as silica gel, naturally attract moisture. They are used to reduce humidity and the resulting cooling loads in hot, humid climates.

Collector Performance Ratings

When you are shopping for solar collectors, you can compare their performance. Look for a Solar Rating & Certification Corporation (SRCC) or Florida Solar Energy Center (FSEC) sticker on the equipment you are considering to check their comparative performance ratings.

A Bright Future

Solar collectors can be used for nearly any process that requires heat. As environmental laws become stricter and the price of conventional power increases, it is likely that solar collectors will be integrated into many applications.

Low-Tech Solar Collectors

Several inexpensive, "low-tech" solar collectors with specific functions are also available commercially. Batch heaters are simple, effective solar water heaters; solar box cookers are used for cooking and for purifying water; and solar stills produce inexpensive distilled water from virtually any water source.
Batch heaters, also known as "breadbox" or integrated collector systems, use one or more black tanks filled with water and placed in an insulated, glazed box. Some boxes include reflectors to increase the solar radiation. Solar energy passes through the glazing and heats the water in the tanks. These devices are inexpensive solar water heaters but must be drained or protected from freezing when temperatures drop below freezing.
A batch heater is a simple solar water heater that uses one or more black tanks filled with water and placed in an insulated, glazed box. Solar box cookers are inexpensive to buy and easy to build and use. They consist of a roomy, insulated box lined with reflective material, covered with glazing, and fitted with an external reflector. Black cooking pots serve as absorbers, heating up more quickly than shiny aluminum or stainless steel cookware. Box cookers can also be used to kill bacteria in water if the temperature can reach the boiling point.
Solar stills provide inexpensive distilled water from even salty or badly contaminated water. They work on the principle that water in an open container will evaporate. A solar still uses solar energy to speed up the evaporation process. The stills consist of an insulated, dark-colored container covered with glazing that is tilted so the condensing fresh water can trickle into a collection trough. A small solar still, which is about the size of your kitchen stove, can produce two gallons of distilled water on a sunny day.

Source List

The following organizations can provide you with information to help you find the solar water heater that is right for you.

American Solar Energy Society (ASES)

2400 Central Avenue, Unit G-1
Boulder, CO 80301
(303) 443-3130
Fax: (303) 443-3212
E-mail: ases@ases.org
ASES is a nonprofit educational organization founded in 1954 to encourage the use of solar energy technologies. ASES publishes a bimonthly magazine, Solar Today,

and offers a variety of solar publications through its catalogue.

Florida Solar Energy Center (FSEC)

1679 Clearlake Road
Cocoa, FL 32922-5703
(407) 638-1000
Fax: (407) 638-1010
E-mail: info@fsec.ucf.edu
FSEC is an alternative energy center. The FSEC staff conducts research on a range of solar technologies, offers solar energy workshops, and distributes many free publications to the public.

Solar Energy Industries Association (SEIA)

1616 H Street, N.W. 8th floor
Washington, D.C. 20006-4999
Phone: 202-628-7745
E-mail: Solarsklar@aol.com
SEIA provides lists of solar-equipment manufacturers and dealers.

Solar Rating & Certification Corporation (SRCC)

c/o FSEC
1679 Clearlake Road
Cocoa, FL 32922-5703
(407) 638-1537
Fax: (407) 638-1010
E-mail: srcc@fsec.ucf.edu
SRCC publishes the thermal-performance ratings of solar energy equipment. The SRCC offers a directory of certified solar systems and collectors as well as a document (OG-300-91) that details the operating guidelines and minimum standards for certifying solar hot-water systems.

For information about many kinds of energy efficiency and renewable energy topics, contact:

Ask an Energy Expert
The Energy Efficiency and Renewable Energy Clearinghouse (EREC)
P.O. Box 3048
Merrifield, VA 22116
(800) DOE-EREC (363-3732)
Fax: (703) 893-0400
E-mail: doe.erec@nciinc.com
Consumer Energy Information Web site

Energy experts at EREC provide free general and technical information to the public on the many topics and technologies pertaining to energy efficiency and renewable energy.

You may also contact your state and local energy offices for region-specific information on solar water heaters.

Reading List

The following publications provide further information about solar collectors. The list is not exhaustive, nor does the mention of any publication constitute a recommendation or endorsement.

Books, Pamphlets, and Reports

1. Consumer Guide to Solar Energy, S. Sklar and K. Sheinkopf, Bonus Books, Inc., 160 East Illinois Street, Chicago, IL 60611, 1991.
2. *The Fuel Savers*, B. Anderson, Morning Sun Press, Lafayette, CA, 1991.
3. *The New Solar Home Book*, B. Anderson and M. Riorden, Brick House, Amherst, NH, 1987.

Periodicals

1. *Home Energy Magazine*, 2124 Kittredge Street, No. 95, Berkeley, CA 94704-9942, (510) 524-5405. Home Energy Magazine is a source of information on reducing energy consumption.
2. *Solar Today*, 2400 Central Avenue, Unit G-1, Boulder, CO 80301. Solar Today covers all the solar technologies, both mature and emerging, in a general-interest format. Each issue includes a solar building case study.

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file - Granite Bay Energy
3 pages
date 20 Nov08

Why Solar?

Solar power make sense! Advances in photovoltaic technology combined with generous local, state, and federal rebates and tax credits have made today's solar electric systems cleaner, more reliable, and more affordable than ever before.

Stop writing checks to the utility company!

Whether you own a home, a small business, or a large commercial/agricultural operation, you probably write a large check to your utility company every month. Over time, those checks can add up to a lot of money—tens of thousands of dollars a month if you own a large organization.

Make Energy Inflation Work For You

When you purchase a solar energy system, it's like buying 30-45 years of energy at a fixed, predetermined cost—locking in power at a fraction of the current charges and preventing future rate hikes. Plus, as energy costs rise, the more the energy you produce is worth—and the more you save! In fact, if you produce more energy than you use, your meter will actually spin backward, generating credits with the utility company.

Invest in Your Home or Business

More than just green, a solar electric system from Granite Bay Energy is a valuable investment in your home or business that can pay for itself many times over—freeing up cash for other activities. Over the lifetime of a solar power system, typically 45 years, it can pay for itself on most structures 6 or more times.

Increase Property Values

A well designed solar system will also increase your property value. According to a study published in The Appraisal Journal, every dollar saved in annual energy costs results in an increase of $10-25 in net home value. That means that if your current utility bill is $200, your home will increase in value by

$24,000 to $60,000—none of which is subject to property tax in California.

Enjoy Tremendous Satisfaction

Plus, when you power your home or business with solar or other renewable energy technologies, you are helping cut our dependence on foreign oil, as well as reducing pollution and harmful emissions. The typical non-solar home produces 350 tons of greenhouse gases over a 25-year period.

Solar FAQ

Q: How do I know if solar is right for my home or business.

A: The best way is to one of our representatives for a free, no-obligation site evaluation. You may also estimate the size, cost, and savings of a new system using a . At this time, solar power technology has achieved a point in its development where almost any building has enough roof or ground space to generate sufficient electrical power to meet the needs of all or most of its occupants.

Q: How long do solar electric systems last?

A: Because solar electric systems are made from high-impact tempered glass, have no moving parts, and require very little maintenance, they can operate for 40-50 years—paying back the initial investment many times over!

Q: Do your solar systems come with a warranty?

A: Yes. In the event that something ever does go wrong, all of our photovoltaic panels come with a 25-year manufacturer's warranty. In addition, Granite Bay Energy covers all other parts of the system—including roof mounts, conduit, and every last nut and bolt — for 10 years.

Q: Do I have to pay for the system up front?

A: That depends on your method of financing. For more information about financing options, visit our page.

Q: How long will it take to pay for itself?

A: Again, that depends on your method of and the size of your current utility bill.

Q: What are the key components of a solar power system?

A: There are five basic components:

1. **Solar Modules** convert sunlight to electrical power. Typically, Granite Bay Energy professionals mount them in a steel frame attached to the roof of a home or commercial property or ground-mount them on a piece of land close to the site.
2. **The Inverter** (or power converter) converts the direct current (DC) produced by the solar modules to alternating current (AC), the same type of electrical power supplied to homes and businesses from the utility grid.
3. Power travels from the inverter to the breaker box, or **electrical service panel**, where it is then distributed throughout the home or business for use.
4. When the solar electric system produces more power than you are currently using (for instance during a work day at a residence or over the weekend at a business), the excess electrical power will flow into the grid through a special bi-directional **utility meter,** effectively causing the meter to run backwards and generating a credit with the utility company that will offset future usage. This arrangement is known as net metering.
5. The **utility grid** is the state and national infrastructure that links homes and businesses to electricity-generating assets. The grid automatically provides electricity when household or business demand exceeds solar production.

For more detailed information about how solar systems work, please visit our page.

Granite Bay Energy
1800 Vernon Street, Suite 1
Roseville, CA 95678
916-791-2426 Phone
916-791-2523 Fax

site design:

file - solar-full.pdf
pages - 87,
26 Jan 09

updated in 2007

Western Governors' Association
Clean and Diversified Energy Initiative

Solar Task Force Report

The Western Governors' Association's Clean and Diversified Energy Advisory Committee (CDEAC) commissioned this task force report in February 2005. Members of the Task Force are listed below. This is one of several task force reports presented to the CDEAC on December 8, 2005 and accepted for further consideration as the CDEAC develops recommendations for the Governors. While this task force report represents the consensus views of the members, it does not represent the adopted policy of WGA or the CDEAC. At their Annual Meeting in June, 2006, Western Governors will consider and adopt a broad range of recommendations for increasing the development of clean and diverse energy, improving the efficient use of energy and ensuring adequate transmission. The CDEAC commends the Task Force for its thorough analysis and thoughtful recommendations.

cost figures
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avoided emissions p 22 of 87
BLM siting EIS p 24 of 87

Members of the Solar Task Force

Glenn Hamer (Chair)	First Solar (CDEAC member)
Fred Morse	Morse Associates, Inc.
Steve Chadima	Energy Innovations, Inc.
David Kearney	Kearney & Associates
Don Aitken	Donald Aitken Associates
Mitch Apper	Sunergy Systems
Rajiv Arya	Oregon Renewable Energy Center
Jon Bertolino	Sacramento Municipal Utility District
Sara Birmingham	Pacific Gas & Electric
Bill Blackburn	California Energy Commission
Bruce Bowen	Pacific Gas & Electric
Dave Cavanaugh	Bureau of Land Management
Mike D'Antonio	Public Service Co. of New Mexico
Kevin Doran	University of Colorado
Todd Foley	BP Solar
Lisa Frantzis	Navigant Consulting
Shannon Graham	Navigant Consulting
Gordon Handelsman	Shell Solar
Thomas Hansen	Tucson Electric Power
John Hargrove	Sierra Pacific Power Company /Nevada Power
Herb Hayden	Arizona Public Service Company
Mike Henderson	Sandia National Laboratory
Scott Jones	R.W. Beck, Inc.

- Demonstrate leadership through **state purchases** of solar energy and **public education:**
  - States can send a clear signal to their citizens about the long-term economic and environmental benefits of distributed solar by purchasing systems for state buildings.
  - Use public education and awareness program to inform homeowners and businesses about the costs, benefits and technology options available to them.

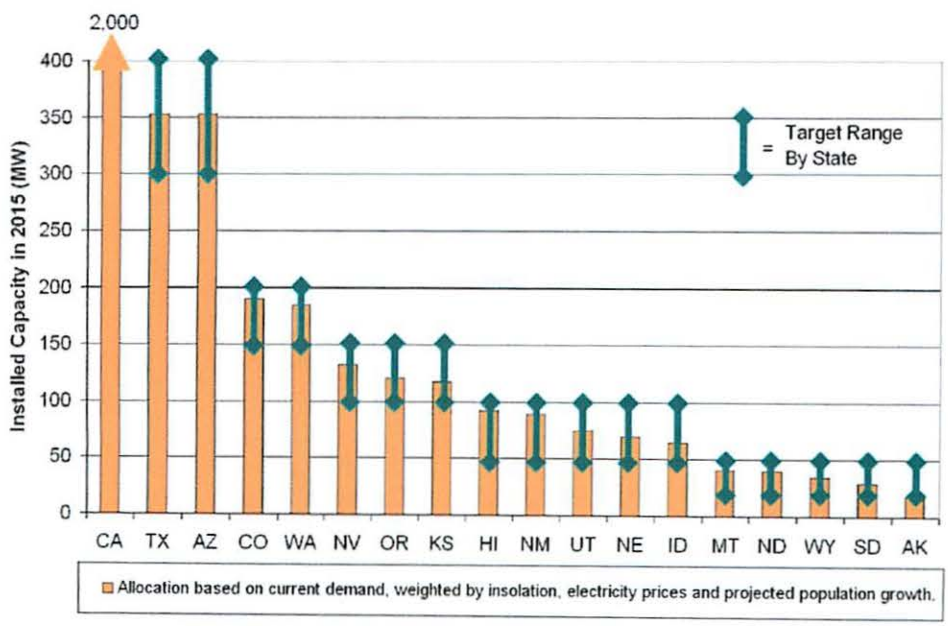
Solar parking lot canopies, such as this one at Cal State Northridge, are highly visible signals to consumers about the benefits of solar

Solar Works in Every WGA State

One of the greatest attributes of distributed solar is that every state can take advantage of its benefits. While the Southwestern states and Hawaii clearly enjoy greater solar resources than states farther north, solar electricity, solar water heating systems and solar space heating and cooling systems will deliver valuable renewable energy throughout the West. While the solar resource in Portland and Seattle is 60% of the solar resource in Phoenix, two-thirds of the Northwest receives as much or more direct sunlight as Florida. Even the rainforests of the Olympic peninsula receive as much sunlight as many areas in Germany and Japan – the two countries with the vast majority of the world's solar photovoltaic installations and among the world's leaders in solar thermal (water and space heating) installations. Over 20,000 solar water heating systems have been installed in Oregon since 1978, for example, showing that solar can thrive in any climate when barriers are removed and the right level of incentives is used to drive demand. That demand, in turn, can fuel a cycle of declining prices and expanding markets.

Based on current demand, weighted by the amount of sunshine, electricity prices and projected population growth, we believe that each state will be able to make a meaningful contribution to the region's energy needs through the installation of distributed solar systems.

Figure II-1. Weighted Allocation of Installed Capacity in WGA States (Total = 4GW in 2015)



Source: NREL

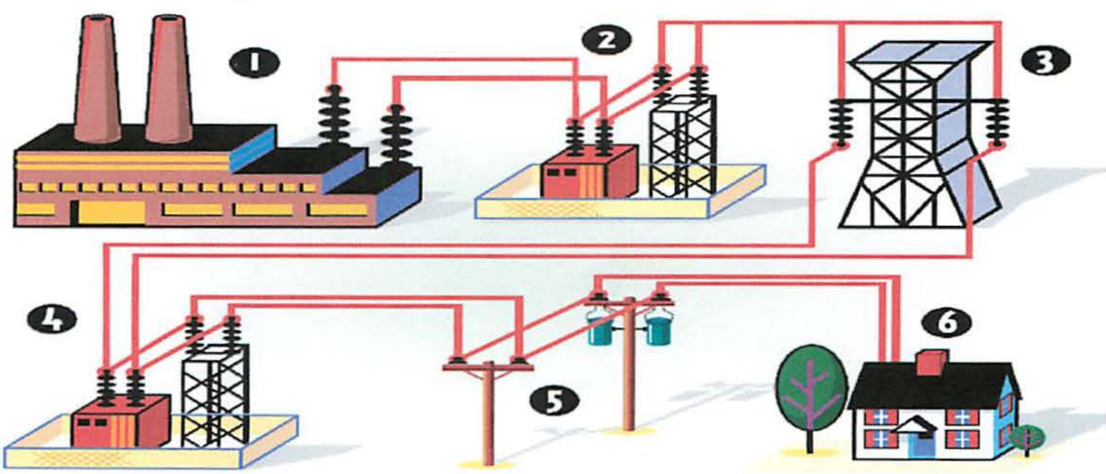
Distributed Solar Benefits All Ratepayers

- **Power is most often produced during critical peak hours**
- **Power is produced on-site, avoiding line losses, reducing the strain on the transmission and distribution systems, and potentially deferring the need for new distribution and transmission investments**

Distributed solar offers many unique and valuable contributions to the economic health of the region and to the stability of the electricity and natural gas distribution systems. However, two broad categories stand out. First and foremost, while each state may have different peak load and system performance characteristics, solar PV systems are often most productive during peak hours – including the time when demands on the electrical grid can be the greatest.[27] This reduces peak electricity demands, resulting in lower peak energy costs and lower price volatility for all consumers. Furthermore, reducing demand for peaking power lowers demand for natural gas, keeping gas procurement costs down. Second, because generation is located at or close to the point of use, a number of benefits can accrue to the entire grid. Reduced line losses help the grid to operate more efficiently, security concerns are lessened, and over time upgrades to the transmission and distribution systems may be mitigated, potentially deferring investment capital.

Figure II-2 demonstrates the steps involved in transmitting power generated at a traditional power plant to the end user. When PV systems are operating, typically during peak electricity demand periods, they provide electricity on site for the PV owner and bypass stages 1 to 5. Although these stages cannot be eliminated since most residents and businesses require electricity 24 hours a day, the strain on these systems during peak periods could be reduced substantially with widespread PV application.

Figure II-2. Schematic of the Electric Power Grid



When electricity leaves a power plant (1), its voltage is increased at a "step-up" substation (2). Next, the energy travels along a transmission line to the area where the power is needed (3). Once there, the voltage is decreased or "stepped-down," at another substation (4), and a distribution power line (5) carries the electricity until it reaches a home or business (6).

Source: Edison Electric Institute, *Key Facts: A Look at the Electric Power Industry*

[27] See Appendix II-1 for a more detailed description by NREL of the region's effective load-carrying capacity (ELCC) – the relationship between the load shape and the resource availability (insolation) in a particular area.

Distributed solar thermal systems also reduce electricity or natural gas consumption at the point of use. Reduced electricity consumption through the use of solar thermal systems is functionally identical to the production of electricity during those same periods, and this potential is further available through the newer solar space heating and solar cooling technologies coming to market. Reduced natural gas consumption translates into more natural gas available for electricity generation and industrial use.

There is a wide range of economic and environmental benefits from distributed solar photovoltaics. The most significant of these are in avoided costs for natural gas for electricity generation and for capital costs to build new plants. Recent studies of the California market indicate a potential for a variety of other benefits, including the value of avoided T&D losses, avoided CO_2 and NOx emissions, avoided water usage, and many others.[28] The California Public Utilities Commission is currently considering which of these are appropriate to include in a formal cost-benefit analysis of its existing subsidy program and how best to calculate the impact of those that are included. Regardless of which are ultimately deemed appropriate to include and at what level, enacting programs that have the effect of reducing costs will ultimately improve net benefits.

Similarly, small-scale solar thermal technologies have both environmental and economic benefits, particularly when systems are used to offset the consumption of electricity or natural gas[29], which along with propane are the primary water heating energy sources used in the WGA states. In many areas in the West, natural gas is used almost exclusively for water heating applications in new construction.

Society Benefits from Distributed Solar Energy

- **Jobs**
- **Healthier environment**
- **Keeps money in region**
- **No water is consumed**

In addition to ratepayer benefits, there are a series of advantages that accrue to society at large. First, developing a distributed solar industry can help to build local and regional economies by creating high-paying local manufacturing and installation jobs, thereby increasing state and local tax revenues. A healthy, growing solar industry, installing solar products that convert indigenous solar resources into usable energy, can have the added advantage of converting into local contracting and manufacturing jobs those dollars that would otherwise be sent out of state or out of the country for the importation of fossil fuels. According to a recent study by researchers at the University of California, Berkeley, the solar industry currently supports 33.25 installation and manufacturing jobs for every megawatt installed[30] – more local jobs per MW than any other energy technology[31] – so the employment leverage offered by an expanded solar market can be substantial. In addition, there is a wide range of environmental benefits, such as reduced use of scarce water resources and avoided emissions of greenhouse gases and other pollutants that further contribute toward the WGA's objectives in its energy program.[32]

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[28] Severin Borenstein, *Valuing the Time-Varying Electricity Production of Solar Photovoltaic Cells*, Center for the Study of Energy Markets, University of California Energy Institute, March 2005; and Ed Smeloff, *Quantifying the Benefits of Solar Power for California*, The Vote Solar Initiative, December 2004

[29] US Department of Energy, Energy Efficiency and Renewable Energy Solar Energy Technologies Program, *Solar and Efficient Water Heating*, 2005.

[30] Virinder Singh, *The Work That Goes Into Renewable Energy*, Renewable Energy Policy Project, 2001.

[31] Daniel M. Kammen, *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?*, Goldman School of Public Policy, UC Berkeley, 2005

[32] See Appendix II-1 for NREL's detailed analysis on reduced water use and greenhouse gas emissions.

What Will It Take to Enable Solar Technologies to Make a Meaningful Contribution to the Region's Energy Needs?

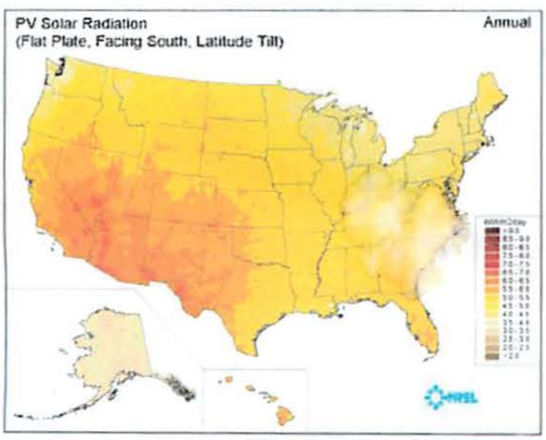
There is a common misconception that solar is too immature to make a meaningful contribution to the region's energy needs. In fact, both the solar photovoltaics and the solar thermal (space and water heating) markets are already substantial. In 2004, over $7 billion of PV systems were sold worldwide, and solar thermal sales are approaching $5 billion per year. PV industry leaders include multinational corporations from traditional energy (BP Solar, Shell) and electronics (Sharp, Kyocera) industries, many of whom have manufacturing facilities in the U.S. Growth in the industry has also been enviable by most industries' standards. Over the past eight years, sales of PV systems have grown an average of 31% annually and solar thermal systems 20% annually, and most analysts expect these rates to continue for the foreseeable future. Solar heating and cooling, although new to the U.S. market, is prevalent in the European Union and is projected to continue to grow. The European Renewable Energy Council is predicting that, for the European Union, renewable thermal cooling and heating can achieve 25% of the total cooling and heating demand by 2020.

Despite this phenomenal growth, the industry still represents less than one-tenth of 1% of the electricity generated in the West, and the US share of those robust global markets is declining markedly. Many thoughtful observers have noted that solar is an industry ready to explode. So what can the current programs in the West and around the world tell us about what we need to do to make that happen? What are the roadblocks we need to clear and the catalysts we can employ to encourage energy consumers to make the levels of private investments in distributed solar needed to help meet the Governors' goal of 30,000 MW of clean energy?

There are No Physical or Technical Barriers to Market Entry

- **Plenty of sunshine**
- **Plenty of roof space**
- **New technologies are providing competition that will ensure continuing decline of average system prices**

Much of what we need to make this happen is largely in place. First, there are no physical barriers to achieving our goals. We have an abundant natural resource in sunlight – indeed some of the best in the world. The maps below[33] indicate the amount of solar radiation in the US annually (left) and during August (right). The annual map indicates the potential for significant year-round contributions from at least ten WGA states. However, in the height of summer, when the grid is straining to meet regional



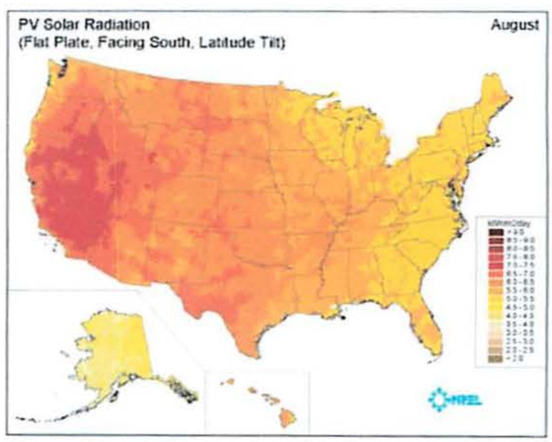


Figure II-3. Solar radiation in the US annually (left) and during August (right).

33 See http://www.nrel.gov/gis/solar_maps.html for detailed maps and an explanation of how they were derived.

electricity needs, every WGA state is in a great position to contribute to the total requirements through distributed solar. By comparison, if one were to plot on this same scale the solar resource in Germany and Japan (which together are home to the vast majority of the world's solar PV installations), their maps would look like the northwest corner of Washington State in most areas of their respective countries.

There is also ample roof space available for distributed solar installations. In September, 2004, the Energy Foundation and Navigant Consulting released a detailed study estimating by state and building sector (residential, commercial, etc.) the amount of roof area appropriate for installing solar.[34] Even after eliminating 78% of residential roofs for such factors as steep angles or improper orientation and 35% of commercial roofs for structural inadequacy, shading and the like, approximately 22 *billion* square feet of roof space in the WGA states appear appropriate for use by solar systems. Although neither recommended nor even realistic, it is interesting to note that the entire 30,000 MW of clean generating capacity sought by the Governors could be generated by less than 18 percent of the available and appropriate roof space. Clearly lack of spots to site solar systems will not be a constraining factor.

In addition, in most areas of the West there appear to be no major technical barriers to success. While additional R&D, largely through federal and private investment, will be needed to uncover the technical advancements that will further drive the industry, existing technologies are ready for market now. Current PV systems already work exceptionally well. Panel failures are extremely low (nearly all manufacturers guarantee their products for 25 years), and the inverters that convert DC power from the panel to usable AC power usually last five to ten years before needing replacement. Given that most of these systems have not been in the field for anything close to their expected lifetimes, many utilities and industry groups are watching the performance of panels and inverters carefully and may have further recommendations for improvements in the coming years.

Solar water heating systems are also typically reliable. The Solar Rating & Certification Corporation and the Florida Solar Energy Center have equipment certification protocols that address collector and system design and performance. Several electric utilities are involved in highly successful solar water heating programs, demonstrating that properly designed programs lead to highly reliable solar energy systems. The Utility Solar Water Heating Initiative (USH_2O) is an electric utility/solar industry collaborative which now counts nearly 30 utility members from across the US, as well as 45 other solar industry, state government and utility commission members, all of whom are working towards developing additional effective and reliable utility-based solar water heating programs.[35] As an example, Hawaiian Electric Company's Energy Solutions Solar Water Heating Program has grown to over 3,000 systems per year since its inception in 1996.[36]

In recent months, there has been a worldwide shortage of PV panels due to the dramatic increase in demand from Germany, leading to a modest reversal of the decades-long trend of declining prices of modules. Exacerbating the problem has been revived growth in the semiconductor industry, which relies on the same highly pure silicon feedstock as its base semiconducting material. There is consensus among manufacturers, however, that these shortages are temporary, and every major manufacturer is bringing on new production lines and/or expanding capacity at existing facilities over the next year. Despite these increases in module costs, overall system costs have continued to decline, according to rebate applications filed with the California Energy Commission's Emerging Renewables Program[37].

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[34] Maya Chaudhari, Lisa Frantzis, and Tom Hoff, *PV Grid Connected Market Potential Under a Cost Breakthrough Scenario*, The Energy Foundation and Navigant Consulting, September 2004. Report can be downloaded at http://www.ef.org/documents/EF-Final-Final2.pdf. Also, see Appendix II-1 for NREL's detailed analysis on rooftop PV potential in the WGA region.

[35] See: http://www.eere.energy.gov/solar/ush2o/

[36] http://www.heco.com/CDA/frontDoor/

[37] See http://www.energy.ca.gov/renewables/emerging_renewables/2005-11-02_post_1_1_2005_update.xls

Beyond Wind: Texas Seeks Solar

The Lone Star state gets a clean energy park and works toward a renewable energy policy.

By Natalie Marquis

Everything's bigger in Texas. The sun shines more than 200 days a year here, on about 64 percent more land area than even California. So with all the sun exposure and all the potential for solar energy production, what is the state of our state?

The answer is depressing but not defeating. While the state leads the nation in wind power development, we still don't have a statewide solar policy, and Austin Energy remains the only utility in the state offering aggressive rebates for photovoltaic installations for both commercial and residential customers. Despite a grassroots effort to kill 11 proposed coal-fired power plants, utilities still hope to build them. On the other hand, at the end of January, Gov. Rick Perry assigned $600,000 for the development of a Texas Clean Energy Park in southeast Austin. The 140-acre park, to be completed by 2010, will be the first of its kind in Texas and will be a hub for research, business and training.

Natalie Marquis

B.J. Stanbery, CEO of Austin-based solar energy company HelioVolt Corp., has been instrumental in getting the park off the ground. Stanbery said HelioVolt "expects to be joined by a collaborative community of academic and industrial partners in developing the future of smart sustainable solar-powered architecture." And there's a familial influence in the park's development, too. Stanbery's father, real estate developer Bill Stanberry (yes, they spell their last names differently), began work on the park idea three years ago, while sitting on a planning committee for the Greater Austin Chamber of Commerce. After a year of study, the committee selected the clean energy park as the most significant component in securing a solar future for Texas.

Solar Policy Needed

Now, says Tom "Smitty" Smith of Public Citizen, an award-winning environmental advocacy organization, in order to catch up to the world in solar energy production and manufacturing, Texas needs a coherent energy policy. To that end, Smith and others have joined forces to develop a roadmap for a solar policy for the state. The Texas Solar Futures Committee was formed for this specific purpose and is composed of members from several non-profit groups, including Public Citizen, the Texas Solar Energy Society (TXSES, an ASES chapter) and other local environmental advocates.

Together with the Texas Renewable Energy Industries Association (TREIA) and Texas Business for Clean Air (TBCA), the group hosted the first Texas Solar Forum on April 24 and 25 at the Capitol in Austin (texassolarforum.org). At the invitation of Gov. Perry, Texas business execs, policy-makers and legislators heard success stories from governors in other states who have successfully implemented statewide solar policies. From jobs in research and development, to manufacturing, sales and installation, there is a great deal of money to be made and carbon emissions to be reduced by endorsing a strong policy. While policy is the goal, it is by making the business case sound that we know such a policy can be adopted. With the right momentum, we hope it will be on the floor when the legislative session convenes in 2009.

Austin Gets Solar Cities Grant

On another front, Austin was awarded one of 13 U.S. Department of Energy Solar Cities Grants. There are four main parts of the grant, which will be administered by Austin Energy and subcontracted to TXSES and Clean Energy Associates Inc. In the first two parts of the grant, the focus is on education and outreach.

- TXSES, in conjunction with area teachers, will develop curricula for K-3, elementary, middle and high school students pertaining to renewable energy, its sources and technologies and the need for energy conservation.
- Austin Energy will contribute $180,000 toward installing solar PV systems on six schools. These demonstration sites will allow students to learn first-hand how the technology works. Data loggers will make it possible for all schools to monitor the solar production of the others so that comparisons can be made based on weather conditions and siting.
- The second phase of the grant deals with proactive marketing of Austin Energy's numerous energy-efficiency, green-building, waste-reduction and water-conservation programs. TXSES will make 50 presentations to neighborhood groups, churches and community centers.
- The third phase of the grant will assess the rooftop solar potential in Austin.
- In the final phase, Clean Energy Associates will study the viability of dual transmission lines — transmitting solar energy during the day and wind energy at night. With the favorable wind and sun conditions prevalent throughout west Texas, this study hopes to show how lucrative and efficient renewable energy transmission can be.

Debating Energy

In other news, the Greater Houston Partnership organized a Presidential Summit on Feb. 28, on the theme "America's Energy Future." Speakers included many oil and coal executives, but also Carl Pope of the Sierra Club and Rhone Resch of the Solar Energy Industries Association, along with presidential candidates Hillary Clinton and Ron Paul.

The University of Texas at Austin held its McCombs School of Business Sustainability Conference on Jan. 24–25. That was followed, on Feb. 22, by a lecture on "Our Energy Future" at the Environmental Science Institute by Professor Michael Webber.

If it is true that children are our future, we need to see that Texas schools and universities educate them about the need for swift action on energy issues. Then, when next we take a snapshot of Lone Star renewable energy, the state may live up to its boast of being Always Bigger. ●

Natalie Marquis is executive director of the Texas Solar Energy Society (txses.org), an ASES chapter. Contact her at info@txses.org.

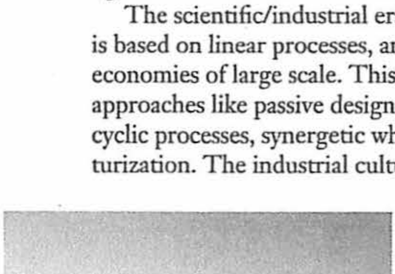
Any building has a metabolism of its own.

Basics of Passive Solar Design

By Ken Haggard

Passive solar design is generally considered to be a technological endeavor. Designing a building that will largely heat, cool, vent, light and power itself requires technical knowledge. However, passive applications also have aesthetic, social and cultural dimensions that are often less recognized. A brief look at the cultural dimension explains why.

The scientific/industrial era, from which we are evolving, is based on linear processes, analysis by isolating parts and economies of large scale. This makes it hard to perceive approaches like passive design that are, in contrast, based on cyclic processes, synergetic wholes and economies of miniaturization. The industrial culture's emphasis on reductionism is also why so much importance is placed on energy production and so little upon appropriate energy use. Problems that result from the isolation of production from use of energy were pointed out by Amory Lovins in his groundbreaking 1979 book, *Soft Energy Paths*. However, due to social inertia, we've neglected this truth. We've become more efficient on the production aspect (what Lovins called the hard path) while becoming massively wasteful on the use aspect (the soft path). Resolving this schizophrenia between production and use at the building scale is what passive solar is all about. One could think of it as a hybrid approach, where production and use are directly related to each other at the building scale. Here, the user can become part of the process rather than just the inhabitant of a sealed box. User awareness of energy production and use is necessary to our cultural transition from a scientific/industrial era to an information/sustainable era.



SLOSG

This off-grid office block, in San Luis Obispo, Calif., provides all its own power for heating, cooling, water, lighting and equipment operation.

Functions Designed Together

The rebirth of passive solar design occurred during the oil embargo of 1973, imposed by members of the Organization of Petroleum Exporting Countries. At the time the emphasis was on space heating. Cooling was assumed to be harder to accomplish passively, except by visionaries such as Harold Hay, who insisted both could be done with passive design using thermal mass and moveable insulation. It took several years of intense effort, funded during the Carter administration, to overcome our reductionist bias and arrive at what now seems obvious: that heating, cooling, ventilation, daylighting and electric power can be provided in an integrated fashion through passive design of buildings. I include photovoltaic power because it fits the classic definition of passive design, which is:

1. The use of on-site energy;

2. Reliance on natural energy flows with a minimum of moving parts;

3. Energy production and use as an integral part of building design.

If multiple energy and thermal functions are designed together, very high effectiveness can be achieved in a variety of climates. Passive solar design has reached the level of sophistication needed to build zero-energy-consuming buildings and even to build net-energy-producing buildings (see photo, left).

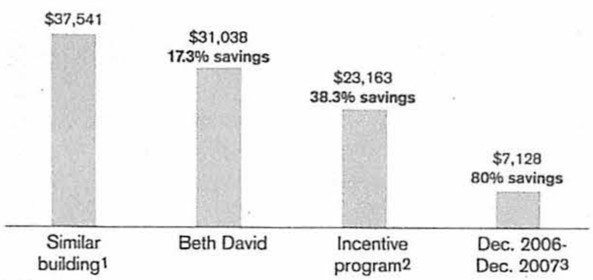
Two Basic Principles

To reach this level, two basic principles must be recognized. First, the building utilizing passive design must be an *energy-conserving* building. However, achieving this necessary prerequisite does not necessarily make a passive building. This distinction is very important. The first principle, therefore, is: *Passive design takes the next step beyond energy conservation to include on-site energy production.*

In California we have what is considered the nation's most stringent energy code for buildings. Yet, this section of Title 24 is largely an energy-conserving code. It doesn't give credit for some very basic passive design elements like night-vent cooling, thermal mass walls or integrated photovoltaic panels. Architects in California can't just rely on the Title 24 calculations to do a good passive building. A passive building can beat Title 24 standards by 40 to 80 percent.

Title 24 Estimates and 2007 Actual Energy Cost

Actual performance of the Beth David Synagogue shows a nearly 80 percent improvement over a comparable structure built to the current Title 24 standard.



1 Title 24 energy modeling software does not account for night ventilation cooling, water walls on the south and intergrated photovoltaic panels.

2 Adjustments in the Title 24 modeling to include more of these passive approaches.

3 This equates to a CO_2 reduction of 90.4 tons/year over a standard Title 24 building.

Source: SLOSC

To illustrate what can happen if these definitions are not understood, I will describe a local situation in San Luis Obispo. Regulations were proposed that would increase the height limit of buildings in the downtown area, while requiring Title 24 to be exceeded by 15 percent in order to move toward the American Institute of Architect's (AIA) 2030 climate stabilization challenge. The local Chamber of Commerce (usually quite progressive), along with the local newspaper, proved uninformed on the technical issues and resisted the plan. Even many architects, all members of the AIA, attacked this regulation as draconian, claiming that Title 24 was the most stringent in the nation and that beating it would create a severe economic hardship. In the resulting brouhaha discussions never progressed beyond Title 24 as an issue, so passive design potentials and the associated cost savings were never addressed.

To avoid this type of confusion, the distinction must be made that passive buildings are *energy-producing* as well as energy-conserving buildings. Providing natural lighting from an optimally designed aperture in the center of a building is energy production, just as much as is burning coal to import energy for artificial lighting, except that the former is healthier, more aesthetically acceptable and doesn't incur line losses. The only downside for the passive approach is that one must design creatively for variation in available sunlight and come up with ways to distribute it. We also need to educate building occupants that they don't necessarily need to flip the switch to have good lighting. Passive design should be the architect's great opportunity, not something to fear.

The second basic principle is that energy functions must relate to the metabolic characteristics of the building as much as to the local climate. A biological metaphor is helpful in realizing this. A hummingbird's metabolism is different from that of a whale. Their metabolisms are massively different because of the differences in size and shape. The same is true of buildings. Small buildings, like hummingbirds, are skin-dominated and large buildings, like whales, are internal-load-dominated.

- *Skin-dominated buildings* tend to have high but balanced heating and cooling needs and natural lighting is relatively easy.
- *Internal-load-dominated buildings* tend to heat themselves due to heat from occupants and equipment, but are more difficult to cool, vent and daylight. Also, large buildings present aesthetic, social and cultural issues, like the relation to surroundings and the degree of user isolation.

The discussion regarding these principles must occur at the earliest stage of design, at the programming level. Too often energy considerations are brought into the design process too late to allow integration with other concerns needed to produce a high-performance passive building.

An Evolving Design Discipline

Passive design has come a long way from the passive solar buildings of 30 years ago when the term was first coined. Some of these advancements are:

1. Achieving multiple functions. Using architectural elements to accomplish more functions has increased the effectiveness of passive design as well as reducing costs. The narrow mindset that we must do this to save energy is progressively being replaced by the realization that this is a more economical, more comfortable and more aesthetic way of building while being healthier for the planet, for our society and for ourselves.

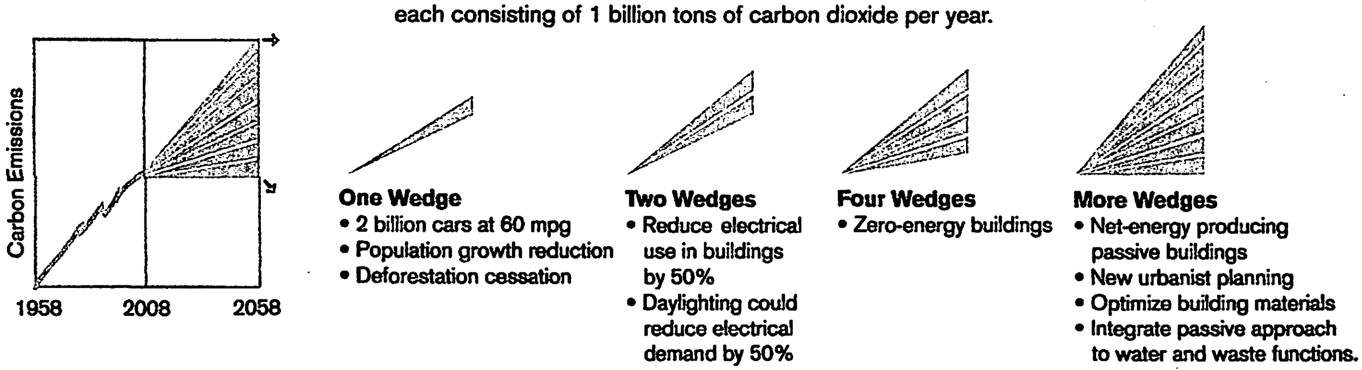
2. Better and more diverse modeling. Since in passive design we are dealing with a complex holistic system rather than discrete parts that are easily calculated in isolation, computer simulation modeling becomes extremely important. Performance-based modeling is far superior to prescriptive-based modeling, as used under California's Title 24 code discussed earlier. The expansion of functions served by passive design means that other models, such as computation fluid dynamics modeling for natural ventilation, are now being used in conjunction with thermal-performance models. Performance simulation and better materials are what now allow us to create high-performance passive design.

3. New materials. It's been recognized for years that the passive solar approach to conditioning is less expensive than active solar devices. For example, in most cases it costs nothing

Small buildings, like hummingbirds, are skin-dominated and large buildings, like whales, are internal-load-dominated.

Building Our Way Out of Global Warming

The difference between carbon stability now and waiting 50 years can be broken into 7 wedges, each consisting of 1 billion tons of carbon dioxide per year.



Source: "A Plan to Keep Carbon in Check," Socolow and Pacala, SCIENTIFIC AMERICAN, Sept. 2006

to orient the building to the south or to provide properly shaded, operable windows for ventilation and winter gain. The biggest expense in passive design up to now has been the thermal mass needed to moderate interior temperature swings and thereby minimize expensive back-up mechanical systems. A promising new material is the nanotech phase-change additive that can be mixed into concrete or into wall panels, thus providing inexpensive but effective thermal mass. This material (Micronal micro-encapsulated wax from BASF chemicals) was used by the winning entry of this year's Solar Decathlon in Washington, D.C. (see "Solar Decathlon Highlights," *SOLAR TODAY*, January/February). For years, passive solar designers have wished for inexpensive, easily applied thermal mass. This may be the grand slam.

However, new products with great promise must be carefully evaluated and made part of the passive design process. An example of unintended consequences occurred with the advent of low-emissive glass. The new technology proved to be so efficient that one form of low-e glass (soft coat/heat rejecting) gave the capability to essentially eliminate any meaningful solar thermal gain through south-facing windows while maintaining normal lighting characteristics. Thus we could design an ideal passive building for heating with just the right orientation, thermal mass, percentage of glazing and size of overhangs. But if we installed the wrong type of low-e glazing, the building would literally fulfill the old in-house joke, "Mass, glass and freeze your a_ _!" This happened too often, because the glass companies found it easier (and cheaper) to market and inventory one type of low-e glass rather than two. The American Southwest was deemed to be an overheating area, so most companies refused to carry the other low-e glass (hard coat/heat receiving). Sales representatives pushed the heat-rejecting low-e glass and many people unknowingly installed the wrong glazing. Reductionist thinking got in the way once again! Only recently, and after much complaining by solar architects, has this unfortunate situation been addressed by the glass industry.

4. Other resource concerns. Energy and carbon costs are becoming part of passive design, with the goal of creating a greener architecture. The carbon sequestering potential of building materials is a new issue. There are also passive approaches to water and waste that promise to reduce the very high material and energy costs of our community infrastructure. Buildings located off the water grid now use rain catchment and new water-free or minimal-water plumbing fixtures. Buildings located away from the sewer grid can incorporate on-site biological waste treatment. These designs qualify as passive just as much as any reduced-energy building designed to be fully powered by an integrated photovoltaic skin.

Potentials of Passive Design

Three of the most critical problems facing us in our new century are global warming, soaring costs for post-peak fossil fuels and resource wars. These are all exacerbated by the way we use energy, and we can help to mitigate them through wide application of passive design. Recent quantification of global warming gives us some inkling of what our best strategies for carbon mitigation could be. Some of these mitigations are reactive and require big changes in behavior. Some are proactive and easier to accomplish. Passive design is part of this second approach. The AIA estimates that about 48 percent of the greenhouse gases discharged in the United States originate in buildings. If that's the case, we've an obligation to design buildings in a way that can help to reduce global warming. With sustainable planning, green architecture utilizing passive design and appropriate technology, we can build our way out of these dire predicaments. ●

Ken Haggard is a principal architect of the San Luis Obispo Sustainability Group, founded in 1976. He was the architect, with Polly Cooper and Pliny Fisk, for the first passive solar building in California in 1972 and the first permitted straw bale building in California in 1992. He is co-author of the Passive Solar Handbook for California *with Phil Niles (1980) and* Fractal Architecture: Design for Sustainability *with Cooper (2007), both available through Amazon.com.*

Turning South Light into North Light

Today's Daylighting Challenge

The trick is to **find the balance** between light and glare.

By Michael Nicklas, FAIA

Over the past 31 years, Innovative Design's 4,750 buildings have routinely incorporated sustainable building practices, and all have incorporated at least one of the many ways of using solar energy. Our buildings have cut our clients' energy bills by $96 million and eliminated 760,000 tons of carbon dioxide. Our peak energy savings now exceed 40 megawatts (111 megawatts of primary energy). The annual energy savings for our clients is $6.8 million.

Like many other designers pursuing passive design, our focus in the 1970s was on residential applications. Mass and glass was the game. Three decades later, if you're designing a passive home, it is still the game. Following technical guidance provided by Doug Balcomb, practical suggestions from Ed Mazria, and many helpful refinements learned from speakers at American Solar Energy Society conferences, our hundreds of designs resulted in more than 4,000 successful passive solar homes. The key was balancing mass and glass amounts and protecting against overheating in the summer. Our passive designs typically reduced heating energy requirements by 40 percent to 70 percent. Because we minimized east-west glass and provided shading for the high summer sun, cooling loads were also reduced.

Daylit cafeteria of the Heritage Middle School in Wake Forest, N.C.

COURTESY INNOVATIVE DESIGN

Today, we mostly design green educational facilities. Our firm has worked on the design of more than 100 K-12 schools that have incorporated solar solutions. Daylighting is the key, particularly in schools. It produces the largest savings and is the most important form giver. With daylit spaces representing a half or more of the total area of our schools, the savings attributed to the daylighting and roof assembly design are significant.

Our strategies for saving energy in schools are obviously different than those used in passive residences, but the importance of pointing our schools south remains the same. Good orientation to maximize southern exposure opens up several cost-effective opportunities for energy savings. Over the years, our daylighting designs have evolved, but we still favor south-facing roof monitors and light shelves wherever possible — from Maine to Northern Florida.

Like other designers who moved from passive solar residences to daylit nonresidential buildings, we have found that consideration for passive heating is still a key factor in the design, even in commercial and educational buildings driven more by lighting — and much more than many engineers appreciate.

Consider Human Factors

Through decades of experience we have learned, first of all, never to overlook human factors. The top priority in daylighting is to create a condition that is superior to that of electrical lighting for the majority of the time the space is occupied. Otherwise, occupants will never lose the habit of walking into a space and turning on the lights. Designers need to develop daylighting strategies that provide superior lighting for two-thirds of the daylit hours. If the norm is just 25 foot-candles of daylight supplemented with fluorescent lighting, the lights will burn.

Efficiency Gains From Daylighting

Peak cooling reduction (kwh)	19 percent
Lighting savings (kwh)	42 percent
Total energy savings (kw)	19 percent

The second key human factor is the elimination of direct-beam radiation entering critical occupant spaces. If you fail to block direct-beam radiation from getting into someone's face, the occupant will soon find a way to block it for you. This conflicts with residential passive-heating strategies, where we often want south-facing windows to put direct-beam radiation onto a dark-colored tile floor. In well-daylit spaces, direct-beam sunlight coming from southern exposures needs to be bounced, redirected or filtered, creating the effect of natural light that comes through high, north glazing.

Why not just prefer north-glazing solutions for daylighting?

Use the Window of Opportunity

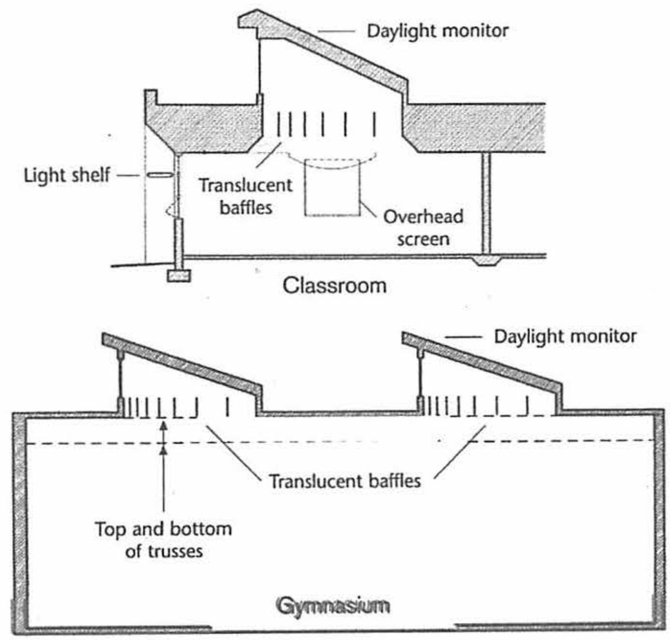
From an energy perspective, the worst thing you can do is to implement a daylighting strategy that is not quite good enough. If you create a situation where you typically have insufficient natural sunlight, resulting in the lights being on, you have created a negative energy situation. You have all the heat produced from the lights as well as the heat created by sunlight. Dimming controls help, but if the daylighting is not adequate, we have found that, regardless of the theoretical calculations, many occupants tend to just override the controls and turn on the lights.

The flip side is also true. If you put in too much glazing you can also get burned. It is easy to just add glazing and achieve a very high daylighting contribution but, as with passive solar-heating designs, you can get too much glass and negatively impact cooling. The key is to implement an optimum amount of glazing that provides superior daylighting and reduces cooling loads, particularly during peak.

While passive strategies primarily attack the heating load, good daylighting strategies result in the lights being out 60 to 70 percent of the time. This reduces the lighting load but also, just as important, the cooling load. With a 60 percent contribution, the habit of flipping on the lights is overcome. More than 70 percent and you are beginning to employ too much glass in achieving the higher levels of illumination. This results in overheating in the warmer months. Until detailed daylighting analysis is conducted, "glass-to-floor area" rules-of-thumb are useful in estimating daylighting glazing amounts for particular approaches in most of the United States, assuming that the daylighting apertures are clear, double glazing. (See figure below.)

Glass-to-Floor Area Ratios for **Best Daylighting**

	Small to Mid-Size Spaces (Classrooms)	Large Volume Spaces (Gymnasia)
• South-facing roof monitor	8 to 11 percent	5 to 8 percent
• South light shelf	8 to 11 percent	
• South light shelf w/blinds between glazing	10 to 18 percent	
• North-facing roof monitor	12 to 15 percent	7 to 10 percent
• High, north transom glazing	15 to 20 percent	



By simulating the varying glazing amounts and overhang lengths during peak cooling times (as well as annual simulations) the best design can be determined. The optimum energy-efficient design allows only enough radiation to provide the necessary foot-candles during peak cooling.

If designed correctly, a daylighting strategy can reduce —

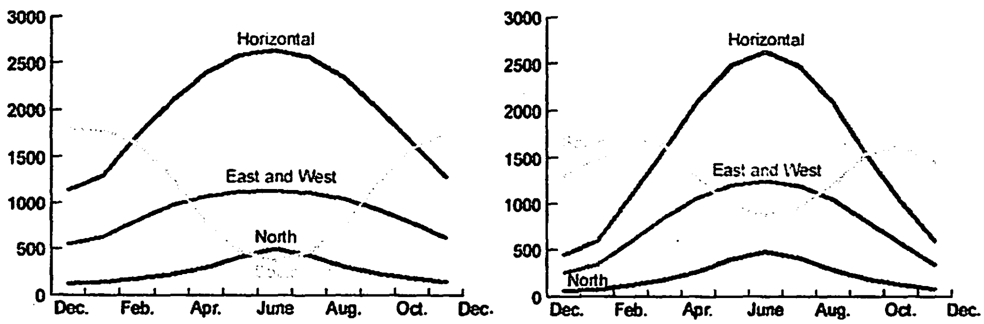
- electricity for lighting and peak electrical demand;
- cooling energy and peak cooling loads;
- maintenance costs associated with lamp replacement; and
- electrical service to the building.

If done wrong, it can increase your cooling energy and peaks.

South Glazing Is the Better Energy Solution

In the hot months, cooling loads can be significantly reduced by providing just the right amount of daylighting in your building. When the lights are out, the cooling load is less because daylighting can produce the same lumens as fluorescent fixtures but result in half the heat. To achieve these cooling reductions it is essential that automated dimming is employed and, during peak cooling times, no more radiation is allowed to enter than is required to meet your foot-candle objective.

Thermal Gains by Window Orientation



Btus/Square Foot of Unprotected Glass/Day at 35 degrees (left) and 48 degrees (right) North Latitude

However, the lights are out not just in the summer. They're out in the winter as well. While this strategy results in a "cooler" lighting in the warmer months, it also means that in the winter, the heat typically produced by the lights is significantly less. By implementing south-facing, vertically placed daylighting strategies that naturally allow increasing amounts of radiation to enter into the space during the winter months, passive solar gains can be used to offset the heating that was being provided by the lights. This is a factor very often overlooked by even seasoned engineers, who tend to use assumptions (typically on a square-foot basis) on the amount of scheduled internal loads generated from lighting. When you take away the heat usually produced by the lights, the areas of the country where limited passive heating makes sense moves southward — all the way to Florida.

North-facing monitors (see drawing, page 11A), while similarly effective as south-facing monitors in providing natural light, are not as energy efficient because they typically require at least 25 percent more glazing to achieve the same annual daylighting contribution. North monitors are beneficial, but, because of the additional glazing and the lack of passive heat benefits in winter, they are not as cost-effective as the south monitor.

The same is true when comparing south-facing light shelves to high, north-facing transom apertures. From a daylighting perspective, high, north-transom glazing can provide good daylighting in spaces that are not too deep. However, like north-facing roof monitors, it is necessary to increase the glass area to achieve the same annual contribution as south-facing light shelves.

By employing south-facing apertures, it is possible to create a strategy that maximizes winter radiation and optimizes summer gain. As can be seen from the accompanying charts, indicating the amount of radiation falling on different flat surfaces, a south-facing aperture is the only orientation that maximizes winter gain and minimizes summer radiation.

The worst glazing placement, from an energy perspective, is typically horizontal — like most skylights. In the summer, just when you don't want the extra radiation, is when you get the most. More than twice the radiation will enter your building through a flat skylight in the summer than in the winter — just the opposite of what you want.

The best way to design a daylighting aperture is to size your glazing and overhangs so that just the right amount of radiation is brought into the space during your summer peak cooling condition. If your glazing faces south, more radiation enters into the space during the coldest months — just what you want. However, with a flat skylight, if the size is optimized for summer peak, there will not be enough daylight to fulfill typical needs the rest of the year.

While skylights can be designed with internal tracking louvers to produce very nice daylighting, it is still difficult to justify their use when it comes to reducing cooling peak loads. Only in a very few areas of the country, where the climate is mild and sky conditions are optimal, should skylights be considered a better energy choice than roof monitors or light shelves.

Summary: Turn South Light into North Light

To reduce conductive losses and improve cost-effectiveness, design your daylighting around south-facing options first. Then utilize north-facing strategies. Bring the sunlight into your building shell through the smallest aperture with the highest visible light transmission you can get. Then, capture the energy benefits of south-facing glazing but filter and bounce the entering sunlight so that it creates the effect of north light. Create north light out of south light and keep the energy savings.

Mike Nicklas, FAIA, is principal of the architectural firm Innovative Design, Raleigh, N.C., and a past chair of the American Solar Energy Society (ASES). Nicklas has held leadership roles in many leading solar energy and sustainable building associations and was the recipient of ASES' highest honor, the 1996 Charles Greeley Abbot Award. Contact him at 919.832.6303 or nicklas@innovativedesign.net.

Personal Principles for Passive Solar Design

By John Reynolds, FAIA

Thanks largely to the efforts of the U.S. Green Building Council, the American Institute of Architects, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, and the 2030 Challenge, the architect's interest in energy efficiency and renewable energy is now higher than I have seen it in 50 years of practice. These topics are the focus of our Architect's Guide to Passive Solar Cooling and Heating in this issue (following page 45).

Designing with our climate has long been an ASES conference theme, and SOLAR 2008, May 3–8, continues this tradition. Daylighting, solar heating and passive cooling are presentation topics at every national conference. Recently, photovoltaic (PV) energy has joined our discussions. Workshops provide opportunities to explore the design tools and hear about case studies first-hand from their designers. Between sessions, architects mingle with researchers, educators, energy policy folks, manufacturers and installers. Every facet of renewable energy is represented.

Designing with climate carries the same challenges it always did. How best to admit daylight without glare and without summer overheating? How to optimize winter exposure to the sun but provide shade in summer? How to flush the building for cooling and fresh air, yet keep it tight in very cold and very hot conditions? Is there a passive approach to reducing summer humidity? Does passive design put too much responsibility on the building occupants to make timely decisions? Do automatic controls result in disinterested, uninvolved building occupants?

As architects seek answers to design challenges, we turn to several sources for help. Design tools and guidelines often come from educators and researchers, products from manufacturers. This in turn produces a second set of challenges. We lack personal access to the authors of the design tools, but we assume their information is unbiased. The manufacturer's representative can come to our office and give detailed, timely advice, but only regarding the company's product.

John Reynolds, FAIA

Fundamentally, if a building is not shaped by design tools and guidelines, then its interaction with the climate is likely to be dominated by products. The all-glass box in the desert becomes uninhabitable without mechanical air-conditioning; the windowless school becomes a display of electric lighting. I gratefully acknowledge the many modern products that improve energy efficiency and allow us to capture renewable energy; but I regret that they make it possible for architects to ignore the climate.

Inspired by this issue's collection of design advice articles from many colleagues, here are personal design guidelines for my own cool-winter/dry-summer climate:

Site:

• Seek good solar access in winter, breeze access in summer.

• Place the building so that comfortable outdoor areas are created in each season. Make them inviting (visible and readily accessible) from indoors.

• Use deciduous trees and vines for summer and fall shading, for buildings and parking areas.

Daylighting:

• Elongate the building east-to-west so that most daylight openings face south and north.

• Keep the building thin enough north-to-south so that daylight penetrates deeply.

• Deciduous vines as awnings will shade the south windows in summer and fall, not in winter and spring.

• Clerestories are usually preferable to skylights, because roof-plane skylights admit hot summer sun and emit heat to winter night skies.

• Provide daylight controls for people near windows.

• Provide automatic controls to dim electric lighting when daylight is adequate.

• Light shelves provide more even interior daylight, so workers farther from windows perceive adequate daylight and keep electric lights off.

Passive solar heating:

• Provide at least six times as much sun-exposed interior thermal mass area as south-facing glass area.

• Insulate the building surfaces beyond code minimums, to hold the solar heat.

• Allow overheated air from south-side spaces to travel to north-side spaces.

• Consider Trombe or water walls where warm interior surfaces on south walls are appropriate. This is especially applicable to spaces occupied in the evening.

• Consider sun spaces where variety in interior thermal environments is appropriate.

Cooling:

• Provide operable windows and clear paths for breezes through the building.

• Use lower openings for incoming cool air, high openings for hot exhaust air.

• Provide a signal system to alert users to the best times for open windows.

• Take advantage of low nightly temperatures by providing at least as much exposed interior thermal mass area as floor area, and provide for either passive or fan flushing by night.

• Shade windows on the exterior in summer and fall.

• Exceed code minimum insulation on the roof.

Active solar water heating and photovoltaic:

• Place collectors in the most solar-exposed places. Roofs usually have best solar access, but collectors can also do double duty as awnings on south facades or as landscape shelter covers.

• Solar collector year-round optimum tilt is at latitude minus 15 degrees, and orientation is due south. However...

• Consult with your electric utility about peak summer loads. It may pay to swing PV orientation westward.

• Be sure to investigate the financial incentives available from local, state, regional and federal entities.

• I like the PV-driven pump on solar water-heating systems. It's blissfully simple and eliminates both differential thermostats and concerns about power failures.

My personal favorite products:

• Thermally massive floors, walls and roofs, especially with insulation included and thermal mass exposed to the interior.

• Windows with high solar heat gain factors for use on south exposures.

John Reynolds, FAIA, is chair of the American Solar Energy Society Board. Contact him at chair@ases.org.

May/June 2008

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A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

NREL National Renewable Energy Laboratory

Innovation for Our Energy Future

10 pages

Modeling Photovoltaic and Concentrating Solar Power Trough Performance, Cost, and Financing with the Solar Advisor Model

Preprint

Nathan Blair, Mark Mehos, and Craig Christensen
National Renewable Energy Laboratory

Craig Cameron
Sandia National Laboratories

Presented at SOLAR 2008 - American Solar Energy Society (ASES)
San Diego, California
May 3–8, 2008

Conference Paper
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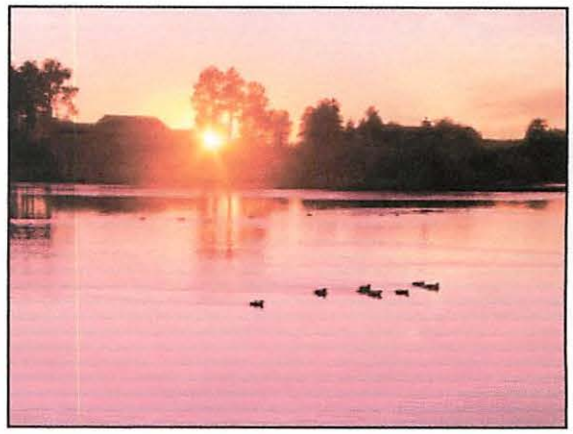
The Sun



Our sun is a giant nuclear fusion reactor running on hydrogen. Each second it converts 564 million tons of hydrogen to 560 tons of helium through the fusion process. The loss of four million tons of mass equates to 91,000,000,000,000 gigawatt hours of energy (a gigawatt is equal to 1,000,000 kilowatts). This is more energy in one second than six billion nuclear power plants would produce in a year.

The sun's energy is an enormous and constant energy resource, but because of the earth's protective atmosphere only a small amount of the total energy produced by the sun reaches earth. Astronomers have determined that the sun's energy has remained relatively constant over the last century and this "solar constant" will continue to be 1.35 kilowatts per square meter (+-3.5%) for about the next four billion years.

On average, the State of Maryland receives 5.3 kilowatt hours per day per square meter of solar energy. Naturally, the amount is higher in the summer and lower in the winter.

On a sunny summer day Maryland receives about 196,000 Gigawatt hours of solar energy. This is more than all the electric power plants in the State would produce in a year. With all of this potential energy, it is no wonder many people find solar energy a useful, environmentally friendly and economical energy source to heat their homes and businesses, as well as water.

We are able to use this vast resource primarily in three ways: passive solar heat, active solar heat, and photovoltaics. The first two energy sources involve collecting the heat produced by the sun for use in heating living or working space, or hot water. Photovoltaics uses the light produced by the sun (or any light source) to generate electricity directly. Sunlight striking a photovoltaic or solar cell causes a voltage and current to be created in a semiconductor that can be used just like the electrical energy from a battery or DC generator.

Passive Solar Thermal Energy

Passive solar buildings are designed with large areas of glass facing south. Because our region is north of the Tropic of Cancer, the sun is never directly overhead. Instead, it is always south of overhead making the southern face of a building the one receiving the most sun.

By placing large areas of glass on the south side of a building, the warmth of the sun passes through the glass and warms the interior of the building. To enhance the solar gain, thermal storage is often added in conjunction with the southern glass exposure. Thermal storage devices can be as simple as dark colored floor tile which helps to store the heat, or as complex as dark colored hollow walls filled with water. As a general rule, the darker the color of a material and the greater (heavier) the density, the better it is at storing heat. For example, a dark tile covered concrete floor is better at storing heat than a white carpeted floor.

Active Solar Thermal

Active solar thermal systems employ solar collectors that concentrate the sun's heat and usually transfer the heat to circulating water. Because the solar collectors are very good at collecting the sun's heat, they can be used not only for keeping a living space warm, but also for providing domestic hot water.

Active solar systems are more complex than passive solar designs. A typical active system has one or more solar collectors mounted on a tilted roof facing south. Water is pumped through the collector, transferring the heat from the collector to the water. The water is then stored in a large insulated tank inside the building. It can then be used to provide heat to the building or provide hot water.

Electricity Generation from the Sun

Photovoltaics (PV) use semiconductor material to convert sunlight directly into electricity. Originally designed for space missions, photovoltaics now produce energy for many cost effective terrestrial applications.

Solar calculators and watches have small photovoltaic cells built into them providing power for the electronics or to charge a small battery in the device. On a larger scale, many PV cells can be combined to make solar modules which can provide enough power for a walk light or a street light. Several modules can be combined into a solar array can provide electricity for house or even commercial buildings.

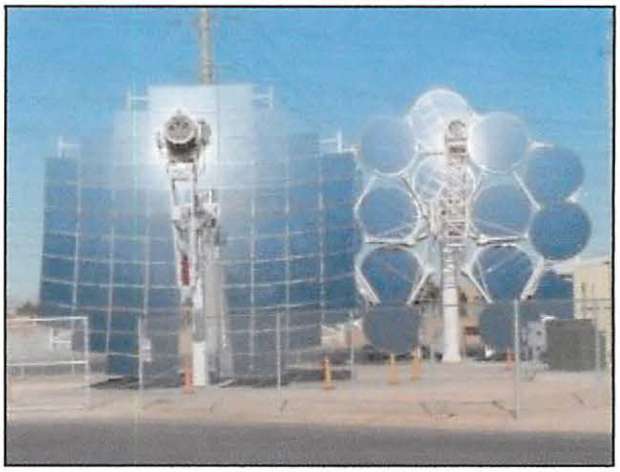
In some cases it is cheaper to install PV to serve small isolated electrical loads than it is to run wires from the electric company. Street lights and roadway sign lighting are two typical applications that are sometimes cheaper than wired service. Some residential customers in remote areas, because they are far away from the electric company's wires, can be served at less cost than running wires to the house.

PV installations that are independent of utility lines are also called off-grid systems. For a typical residence to be off-grid it would require approximately 4 kilowatts (kW) of photovoltaics. Because PV produces power only when the sun is shining, an independent residential system must include batteries to store energy when the sun is not shining. Often these systems include a backup generator (gasoline, diesel or propane) to provide additional assurance that power will always be available. The cost of a complete off-grid residential PV system is about $40,000 to $60,000.

More common uses of PV are utility interconnected, or grid-tied, systems. These systems use electricity generated from the sun and electricity provided by an electric company. There is more flexibility in designing these systems since whatever power requirements are not met by the PV system will be provided by the electric company. Typical residential installations are from under 1 kW to over 3 kW with a cost range from under $9000 to over $30,000. Grid-tied systems do not provide electricity during power outages or at night unless they are designed with an optional battery storage system. Grid-tied systems can also take advantage of the Maryland Net Energy Metering law and feed any excess generation onto the utility grid.

Local solar consultants, designers and installers can be found on the Maryland, DC, Virginia Solar Energy Industry Association (MDV-SEIA) Web site www.mdv-seia.org.

Solar Thermal Generation



Electricity also can be produced by concentrating the sun's rays onto a small location. By using reflectors (mirrors), the concentrated rays magnify the sun's heat to the point where steam can be produced. The steam is used to turn a steam turbine much like an ordinary power plant produces electricity.

A new technology called the "Sterling Dish Engine" uses concentrated solar energy to run an external combustion engine. The engine drives a small generator typically producing from 5 to 25 kilowatts of electricity at peak. Sterling engines, together with their solar concentrators, are small and portable and can be sited near electrical loads. The sterling engine also can be powered with natural gas or propane so energy can be produced even when the sun isn't shining.

Additional Information

- Maryland Solar Programs
- A Consumer's Guide: Heat Your Water with the Sun
  This publication introduces consumers to solar heating technologies, and guides them through the basics of the technology and how to purchase it for the home.
- Mid-Atlantic Region Consumer's Guide to Buying a Solar Electric System
- Moving Toward Zero Energy Homes
  This fact sheet describes the different projects and partners in the Zero Energy Homes initiative. A Zero Energy Home combines state-of-the-art, energy-efficient construction and appliances with commercially available renewable energy systems such as solar water heating and solar electricity. This combination can result in net zero energy consumption from the utility provider.

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10 Feb 07/B2

Solar Power Heats Up

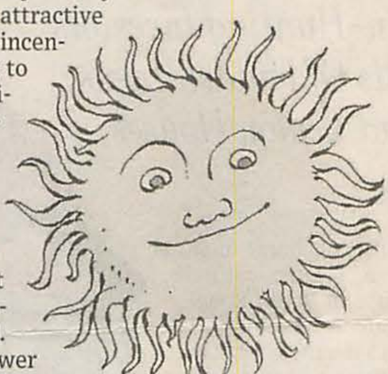
State and Federal Incentives Help Lure Consumers

By STEPHANIE I. COHEN
Special to the WSJ

THE RACE is on to install solar-energy panels in American homes, thanks in part to generous government incentives such as California's $3.2 billion solar initiative, which was launched in January.

Only about one-thirtieth of 1% of all the electricity produced in the U.S. is generated by solar power. But recent technological advances and a continued decline in the price of solar-power systems are prompting homeowners to ask if this renewable-energy source is worth the investment.

Other states with promising residential solar markets include New Jersey, New York, Arizona and Texas. Analysts say these states are becoming more attractive through generous state rebates, incentives offered by utilities willing to buy back solar power from residents in order to meet state renewable-energy requirements, and natural elements such as the days of available sunshine.



On the federal level, homeowners are eligible for a one-year tax credit for 30% of the cost of a residential solar-power system up to $2,000 through 2008.

But do residential solar-power systems, also called photovoltaic or PV systems, make economic sense? The answer hinges on how much and how fast solar energy can cut a homeowner's utility bills, and on how long it takes to pay off the initial investment to add solar panels to a home.

Consumers considering solar power tend to focus on the upfront costs. Solar-energy systems for homes begin around $25,000, but can go higher depending on the size of a house and the amount of power generated, says Rhone Resch, president of the Washington-based Solar Energy Industries Association, which represents manufacturers.

In New Jersey, a 10-kilowatt residential solar-power system is estimated to cost $77,500. After a state rebate of $38,000 and a $2,000 federal tax credit, the out-of-pocket cost to the homeowner is $37,500. That will provide an estimated annual savings of $1,500 on electricity bills.

The payback period for such a system is roughly 25 years at current utility rates, according to estimates provided by the New Jersey Board of Public Utilities. The payback period can drop to about 10 years if a system owner sold $2,400 a year in solar renewable-energy certificates—which are doled out each time a solar-energy system generates 1,000 kilowatts of power—to electric suppliers, which are required to generate a certain portion of their power from renewable-energy sources.

A key factor in any calculus is the cost of electricity rates for a homeowner, says Jeffrey Bencik, an analyst with Jefferies & Co. in New York. Retail electricity prices can vary from a low of eight cents a kilowatt hour in some parts of the U.S. to as high as 18 cents in San Diego, he says. In some areas, residents have seen rates rise as much as 70% in recent years.

BP PLC offers a cost calculator on its Web site (www.bp.com) that uses a homeowner's Zip code and monthly electric bill to calculate what it would cost to install a system and the rebates that are available.

In a report released in January, CIBC World Markets, a unit of **Canadian Imperial Bank of Commerce**, looked at the likely payback for residential solar-power systems installed in California and considered the cost of solar-energy systems, government-sponsored incentive programs and electric rates. The returns, it says, weren't "stellar."

Here Comes the Sun

States are adding incentives for homeowners to install solar-power panels. But does it make sense financially?

Solar-energy systems for homes begin around $25,000, but can easily go higher depending on the size of a house and the amount of power generated.

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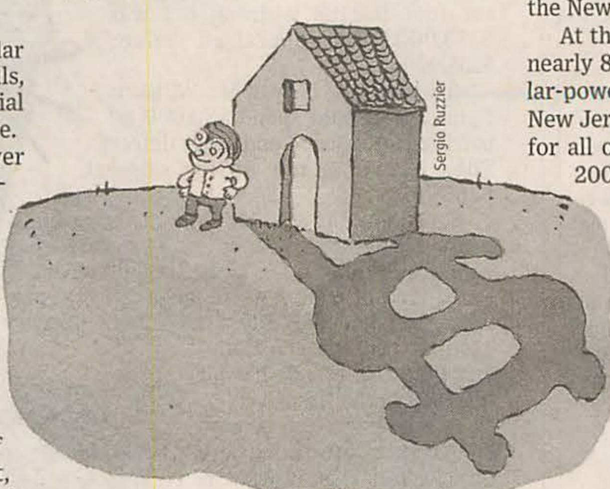


CIBC estimates that the cost to install a system in California is about $8.50 per watt. But after a $2.20-per-watt state rebate and a $2,000 federal tax credit, the net cost drops to $5.77 per watt.

This means that buying a solar-power system can yield homeowners a 6% return on their investment. It would take about 16 years to pay the initial investment, though the payback period can vary depending on peak electricity rates in the region, the report's authors said in an interview.

Many states also feature "net metering" programs, which allow homeowners to sell extra power they produce back to their local utilities, potentially lowering the payback period. Ideally the payback period needs to get down to the "lower double digits or the high single digits" to attract more investors, says Jeff Osborne, an analyst at CIBC and co-author of the report.

Rebates and incentives vary by state. New Jersey offers homeowners as much as 50% in rebates toward the purchase price and installation cost of a solar-energy system. The rebates used to be as high as 70% but increased interest led the state to reduce them in order to accommodate more applications, says Doyle Siddell, a spokesman for the New Jersey Board of Public Utilities.

At the end of the third quarter of 2006, nearly 800 residential and commercial solar-power systems had been installed under New Jersey's program, compared with 493 for all of 2005, according to the state. In 2001, the first year of the state's Clean Energy Program, there were only six solar-power installations. The increase "has been drastic and dramatic," says Mr. Siddell.

In California, close to 21,000 PV systems were connected to the power grid as of the middle of last year, representing about 174 megawatts of power, according to a report by the Northern California Solar Energy Association, a nonprofit group. The California Energy Commission processed 11,734 PV incentives between 1998 and 2004, or an average of 163 a month. From January 2005 through June 2006, the commission processed 13,714 incentives, or about 762 a month, the report said.

The state has made a big solar wager. Gov. Arnold Schwarzenegger last year signed legislation funding the installation of one million rooftop solar panels for homes, businesses and schools. These systems will generate 3,000 megawatts of power for the state and eliminate three million tons of greenhouse-gas emissions, the governor said.

BOUT THE HOUSE | By Gwendolyn Bounds

Let the Sunshine In

Sick of high energy bills, our columnist investigates solar options

THIS MONTH, I've spent hours tramping across my roof with energy experts. We've measured its pitch, calculated how closely it faces true south and used high-tech tools to determine what times of day and which months the rooftop will be shaded.

The goal: to figure out how much the sun's free power can offset my home's hot-water and other energy needs.

Like many Americans swooning from higher heating and cooling costs I'm in the camp of "something's got to change." On one hand, I've taken many small steps to make my 1978 home more efficient: adding insulation, hiring an energy auditor to pinpoint air leaks, tuning the oil-fired boiler and replacing old appliances with Energy Star models. Last weekend, in 80-degree weather, I even shopped for a cleaner-burning wood stove certified by the Environmental Protection Agency.

But not until now, with a costly winter on the horizon, did I investigate solutions to seriously wean my home from fossil fuels. The average U.S. household is expected to spend 33% more this winter on heat, according to the U.S. Energy Information Administration. Renewable-energy options that once seemed far-fetched or unaffordable suddenly look enticing, not just environmentally sound. "We've fundamentally turned a corner," says Jonathan Rose, whose New York-based Jonathan Rose Companies LLC helps plan and develop environmentally sound housing communities.

So how to choose? In my neck of the woods in New York's Hudson River Valley, oil is a prevalent fuel for home heating, as in many areas of the Northeast. It's also used to produce domestic hot water in many homes (including mine), which means the boiler operates year-round. Natural gas isn't offered where I live; a smaller percentage of houses near me use propane while others use electric. Five years ago, with oil at about $1.50 a gallon, the roughly 1,000 gallons my home consumes annually made my system a pretty good deal. This winter, oil is expected to average $4.66 or more a gallon in this region, says the EIA.

I considered energy alternatives like wind and geothermal heat drawn from the earth. But there's no good place to install a windmill on my property, and geothermal would require potentially disruptive retrofitting of my house because its baseboard hot-water-heating system isn't readily compatible. According to one estimate, it would cost about $48,000 to drill the needed wells, install equipment and run ductwork. So I focused on solar energy.

Sun power gained traction in the U.S. during the last energy crisis in the 1970s. It went into a cold spell when tax incentives lapsed under President Reagan and oil prices fell. Now it's making a comeback. For starters, consumers are more focused on environmental issues such as global warming. Plus, new federal and state tax credits and rebates are available to homeowners, and systems often can be rolled into mortgages for new construction. (To find perks in your area, visit dsireusa.org.) Sweetening the pot, many electric utilities have "net-metering" programs under which houses equipped with photovoltaic systems, which convert sun into electricity, can sell excess power back to the grid.

Nationally, an average-size, 4.5 kilowatt residential photovoltaic system costs $40,000 to $50,000, before any tax credits or rebates, according to the Solar Energy Industries Association. The lowest estimate I got was about $17,500 after rebates and credits, with an estimated payback period of 15 years. (A kilowatt-hour equals the energy needed to run a 100-watt bulb for 10 hours.)

But for a smaller investment, sun can be used to heat water for showers, laundry and dishwashing. At $2,000 to $8,000, these solar-thermal systems typically pay for themselves in under a decade. With extra equipment, they also can help heat homes. "It's a very quick and easy way to get yourself out of two-thirds of your hot-water bill," says Jeff Irish, a former General Electric Co. executive who runs Hudson Valley Clean Energy in Rhinebeck, N.Y., which designs and installs renewable-energy systems.

The industry is cooking. U.S. installations of solar water heaters nearly tripled between 2005 and 2007, according to the SEIA. Last month, Hawaii became the first state to mandate solar water heaters in most new homes beginning in 2010. Residents in cold-weather markets are investing, too: New York, Colorado and Illinois rank among the top states installing the solar thermal technology, the trade group says. "This spring, it really took off," says Randall Reu, managing director of Solar Water Works LLC, a solar-equipment distributor in Middlesex, N.J.

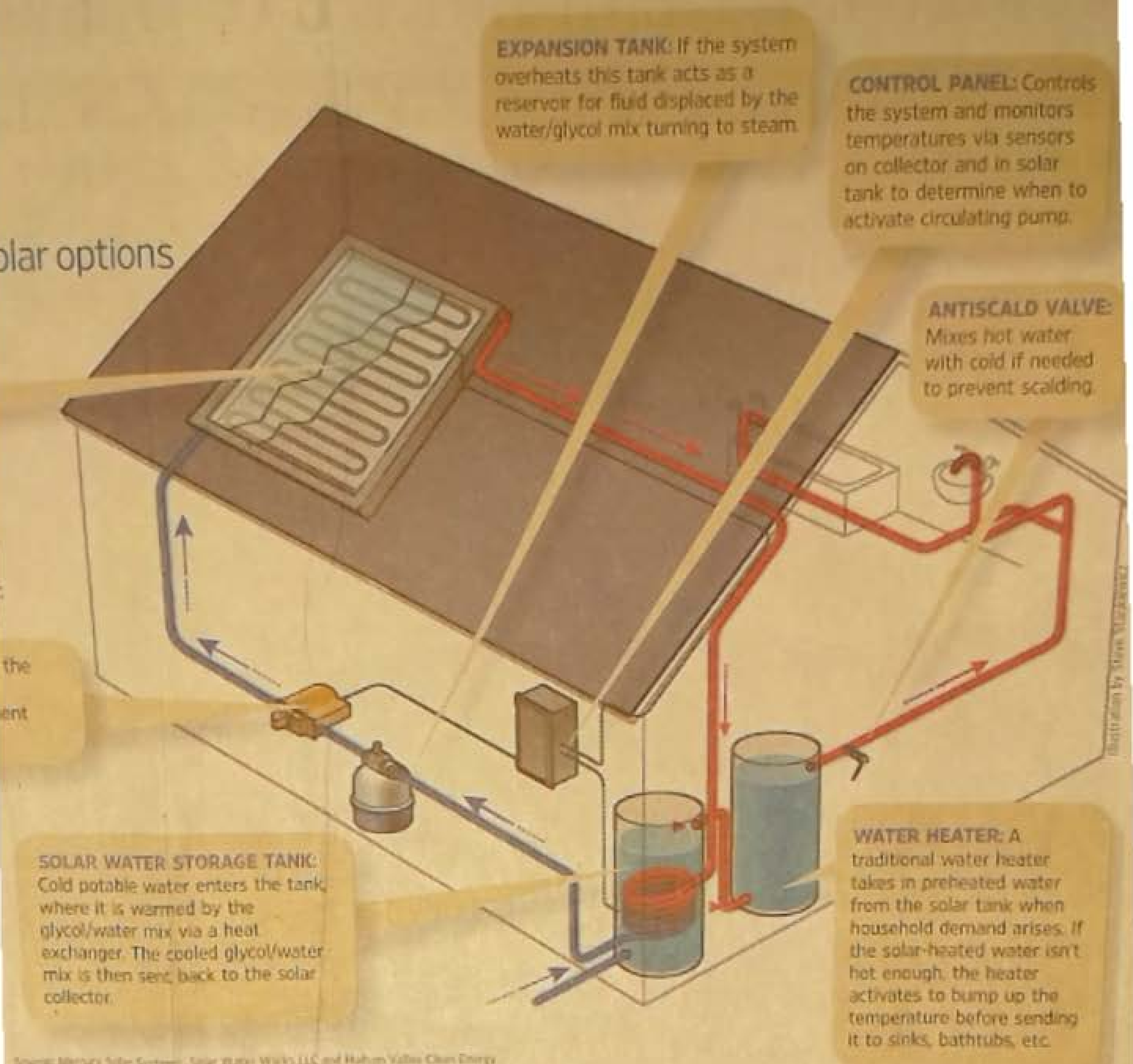
Source: Mercury Solar Systems, Solar Water Works LLC and

Configuring a solar water-heating system varies, but most include a water-storage tank inside the house and solar collectors outside, often on the roof. In one typical design for areas with cold weather, the system pumps a nontoxic antifreeze fluid (a propylene glycol/water mix) through the collectors to be warmed by the sun and then down into the storage tank. There the fluid passes through a heat exchanger to transfer the warmth to potable hot water stored in the tank. The solar tank feeds that warmed water into the home's existing water heater. On days when the solar tank's water doesn't get hot enough, it's heated further by the water heater.

The first step is to determine how solar-friendly your home is. I started with the New York State Energy Research and Development Authority to find a qualified installer. The Department of Energy also helps sponsor a site, findsolar.com, which lists certified installers by state, as does the North American Board of Certified Energy Practitioners (nabcep.

HOME

olar options



Source: Mercury Solar Systems, Solar Water Works LLC and Hudson Valley Clean Energy

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I brought in several local pros. The good news: They pointed out I have a long swath of uninterrupted roof (no vents or other obstructions) facing south, which is optimal for positioning solar collectors or photovoltaic panels. The not-as-good-news: My roof's gentle pitch makes it tough to get direct sunlight in winter, and a grove of deciduous trees casts shade or filters the sun even in winter when the leaves are off.

"That's your bad boy right there," said Anthony Conklin, an inspector for Mercury Solar Systems of Greenwich, Conn., pointing to a looming sugar maple. Up on the roof, he whipped out a tool called the Solmetric SunEye, which snapped digital pictures of my site to plot solar exposure year-round. He and the other contractors concluded that the combined one-two punch of shade and low roof tilt meant a photovoltaic system wouldn't qualify for a full state rebate without some serious tree-trimming.

However, most pros I contacted said a well-positioned solar-thermal system, which operates more efficiently than photovoltaic, might be a cost-effective way to dip my foot into renewable energy. A federal tax credit of 30%, up to $2,000, is in place through 2008; a New York state credit will knock the cost down 25% more, putting my net cost for a simple two-collector, one-tank system at $5,000 to $6,000.

Depending on the system and the annual rise in energy prices (my estimates assumed a 3.5% to 5% annual increase), the estimated payback time was five to 10 years. Switching to a solar-compatible on-demand tankless water heater could help further shave my oil bill by eliminating standby heat losses in a regular water heater. A bigger solar system could help preheat water for space heating.

I'm still mulling my move and haven't given up on photovoltaic. Tuesday, an arborist came to assess the trees. Meantime, my oil company sent a letter locking in record-high winter pricing of $4.88 a gallon. The company's owner wrote: "There are no overnight miracles but if we are courageous, strong and work together, this too shall pass..."

That's sunny optimism of one sort—but I might need technology as a backup.

WSJ.com

Get a checklist of things to do before you install solar power, plus added resources and Web sites, at **WSJ.com/RealEstate**

Los Alamos NATIONAL LABORATORY **News and Communications Office home.story**

Lab a partner in solar energy project

By Tatjana K. Rosev

August 20, 2008

Providing electricity for Northern New Mexico

Story Tools

SHARE

The Laboratory is part of a technical and business case team on a project designed to provide electricity from solar energy for a large area of rural Northern New Mexico.

The Kit Carson Electric Cooperative Solar Photovoltaic Project is being unveiled at 5 p.m. today at the University of New Mexico's Taos campus.

The project's case team was formed under the direction of Elmer Salazar of the Technology Transfer (TT) Division as part of Los Alamos's Northern New Mexico CONNECT's LINK Program, a plan that fosters economic development through enterprise networking. Sandia National Laboratories and various partners from the private sector are partners in the effort.

"Kit Carson Electric Co-op has been a national leader in new business development," Salazar said. "It has constantly strived to better serve its members by branching out into Internet Service Provision (IPS) and propane, and now into solar photovoltaic (PV) energy generation. [The Laboratory] was asked to help the co-op think through the technical and business case for successful distributed production-level deployment of solar photo voltaic electric generation with a direct grid connect approach," he said, adding that the project represents a wonderful opportunity for national laboratories to collaborate with private industry to generate clean power for New Mexico.

The project will deploy one megawatt of distributed solar photo voltaic power destined for Taos (400 kilowatts for UNM/Taos; 150kw for the Kit Carson facilities; and 100kw for KTAO, the Taos solar radio station) and El Rito (350kw for Northern New Mexico College). The project is, to date, the largest deployment of production solar PV in the state.

The production system consists of a direct grid connect system where power exceeding the immediate needs of on-site customers goes directly into the local grid for distribution and use by co-op members. Energy accumulated in the grid during the daytime is fed back to consumers during the night hours, guaranteeing seamless around-the-clock service, Salazar explained.

The project was designed and built by the California office of American Capital Energy (ACE). ACE will oversee installation and maintenance through local contractors and Kit Carson operating staff in order to develop and build local solar construction and maintenance capacity in compliance with objectives set by the Kit Carson Electric Cooperative (KCEC) and the project team through the request for proposal process.

Los Alamos and Sandia labs and private sector partners helped Luis Reyes, president and CEO of Kit Carson Electric Cooperative, and the trustees of the KCEC Board develop the project, which is intended as a model for other rural electric co-ops nationwide. Already, the project team is helping Springer Electric Co-op, which is bidding on a 500 kilowatt system that will be centrally deployed with a direct grid connect at a substation near the town of Springer, to set up a similar solar energy project.

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The Power Behind Your Local Electric Co-op

Search

Tri-State and First Solar sign major development agreement
30-megawatt New Mexico solar facility among world's largest photovoltaic projects

Tri-State Generation and Transmission Association has entered into an agreement with Tempe, Ariz.-based First Solar, Inc. to develop a 30-megawatt (AC), 500,000-panel solar photovoltaic power plant in northeastern New Mexico. The "Cimarron I Solar Project" is the largest photovoltaic project by an electric cooperative and among the largest facility of its kind in the world.

Click here to watch a visualization of the project

"Tri-State is committed to renewable energy in our resource planning that brings value to our member cooperatives across the four states we serve," said Tri-State general manager and executive vice president Ken Anderson. "It's noteworthy that Tri-State's first utility-scale renewable energy project will be among the largest solar photovoltaic projects in the world."

A workforce of 120 to 140 construction personnel will be required during construction of the facility, which is scheduled to commence by April 2010, with the first portion of the system producing energy by August. The facility is scheduled to be fully operational by the end of 2010.

"New Mexico has some of the best renewable resources and workforce in the West," said New Mexico Governor Bill Richardson. "Tri-State's and First Solar's investment in the state will create jobs and advance our agenda for renewable energy."

The project will be located on a 250-acre parcel of land in Colfax County, located between the towns of Cimarron and Springer, N.M. – within the service territory of Springer Electric Cooperative, one of Tri-State's 12 New Mexico member co-ops.

"Tri-State's development of the facility in our service territory benefits all of its 44 members in meeting our consumers' renewable energy and environmental goals," said David Spradlin, general manager of Springer Electric Cooperative. "It's good to see that solar energy is finding a viable home within Tri-State's generation resource mix."

The facility will provide enough energy to serve the equivalent needs of approximately 9,000 homes and help Tri-State to displace emissions of carbon dioxide. "This is a significant venture for Tri-State that meets several objectives identified by our board of directors," said Anderson. "It further diversifies our generation mix, it assists us in addressing carbon emissions and it helps meet our members' renewable energy requirements."

The solar field will consist of approximately 500,000 2' x 4' photovoltaic modules constructed with First Solar's patented thin film semiconductor technology. First Solar will act as the engineering, procurement and construction (EPC) contractor and will monitor and maintain the facility.

"We are excited to be part of Tri-State's first utility-scale PV power plant and the largest PV power plant serving a cooperative in the United States," said John Carrington, First Solar executive vice president of marketing and business development. "This 30-megawatt PV power plant is another important demonstration of our ability to provide affordable, utility-scale solar solutions."

Tri-State has contracted to purchase the electricity output from the facility for a 25-year period. Financial and operational terms of the agreement are confidential.

– should be public

Related visuals – computer animation video and still shots, photography of the project site and company logos – are available for download at:
http://www.tristategt.org/NewsCenter/media-resources.cfm

Updated: March 24, 2009

Tri-State Generation and Transmission Association, Inc. 1100 W. 116th Avenue Westminster, CO 80234 (303) 452-6111

Economic, Energy, and Environmental Benefits of Concentrating Solar Power in California

May 2005 – April 2006

L. Stoddard, J. Abiecunas, and R. O'Connell
Black & Veatch
Overland Park, Kansas

NREL Technical Monitor: M. Mehos

Prepared under Subcontract No. AEK-5-55036-01

Subcontract Report
NREL/SR-550-39291
April 2006

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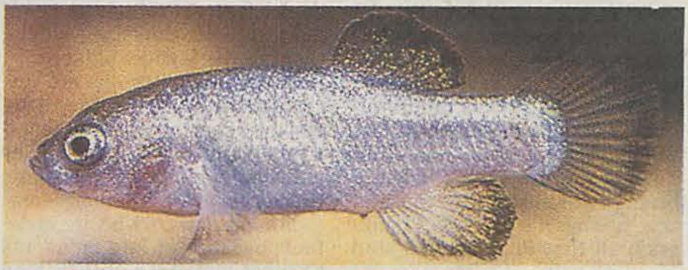
In a Small Fish, a Large Lesson In Renewable Energy's Obstacles

By Stephen Power

WSJ 16 Jun 09 A11



Associated Press (2)

Scientists study rock pools that are home to the Devil's Hole pupfish, above.

WASHINGTON—President Barack Obama wants to boost the nation's production of energy from the sun as part of an effort to double renewable power generation in three years. Among the obstacles to Mr. Obama's agenda: the imperiled Devil's Hole pupfish.

ENVIRONMENT

Patrick Putnam is a field manager for the U.S. Bureau of Land Management in southern Nevada. His job is to help the government decide whether the dozens of solar-energy projects that companies have proposed building on federal land in his jurisdiction pose undue environmental risks.

After reviewing some applications for as long as 18 months, Mr. Putnam's office hasn't approved any. He says his office hopes to make decisions on at least three by the end of 2010, but that will be "a monumental task."

Across the West, companies that want to build renewable energy projects are rushing to stake claims on public land, hoping to grab federal subsidies and take advantage of state mandates that require utilities to obtain more power from renewable sources. The surge is straining the Bureau of Land Management, which is more accustomed to processing permit requests from oil and natural gas companies.

The logjam highlights a dilemma for the Obama administration: how to speed the transition to a clean-energy economy—a shift the president has promised will create millions of jobs—without trampling the legacy of a previous generation of conservationists, who left in place federal laws and regulations designed to control exploitation of federal lands or protect the habitats of endangered species.

Many of the projects that the government is considering allowing on public land use a system known as concentrating solar power. These systems often require large amounts of water to cool the turbines that are used to convert the sun's heat into electricity. Because water is scarce in many parts of the Southwest, some land managers have questioned their suitability. Most of southern Nevada's valleys, for example, receive only four to six inches of rainfall a year.

Complicating matters, some of the proposed projects are in southwest Nevada's Amargosa Valley, a basin near Las Vegas that is home to the endangered Devil's Hole pupfish. The one-inch-long, iridescent blue creature was the subject of a 1976 U.S. Supreme Court decision that restricted how much water nearby farms could pump out of the ground. The pumping lowered water levels in the pools where the pupfish lived, shrinking the species' numbers.

Mr. Putnam's agency is obligated to worry about whether using water for solar-power systems could lead to more pressure on the pupfish. "This renewable energy push is so new and has come about so quickly, and in fairly large numbers, we're trying to figure out the best process" for vetting projects, Mr. Putnam says.

The Bureau of Land Management, a unit of the Interior Department that manages 256 million acres of federal land, has a backlog of more than 200 proposed solar projects, some of which have been waiting several years.

Many solar developers fear the agency won't approve their projects in time for them to qualify for federal aid. Under the economic-stimulus bill passed by Congress in February, solar companies must begin construction by the end of next year to qualify for grants from the Treasury Department valued at up to $2.5 billion.

Among those waiting on the BLM is Solar Millennium AG. Since October 2007, the Germany-based company has had an application before the bureau to build a $1 billion solar plant in the Amargosa Valley.

"We're a bit nervous," Rainer Aringhoff, president of Solar Millennium's U.S. subsidiary. To begin construction by December 2010, he says, the BLM would have to complete an environmental review of the project by the third quarter of next year. Mr. Putnam says the BLM can't commit to a firm date for completing a review.

Mr. Obama's Interior Secretary, Ken Salazar, has called the BLM's backlog "not acceptable" and announced his department will create four renewable energy coordination offices to accelerate the permitting of renewable energy projects on federal land.

The Interior Department estimates that public lands in the western U.S. could generate 206 gigawatts of wind energy and 2,900 gigawatts of solar energy—collectively about three times current U.S. electricity generating capacity, according to the Electric Power Research Institute, a nonprofit in Palo Alto, Calif.

But some lawmakers don't want Mr. Salazar to go too fast. Sen. Dianne Feinstein (D., Calif.), who controls Mr. Salazar's budget as chairwoman of a Senate appropriations panel, said at a recent hearing that such projects should be approved "in moderation," and expressed concern that some could leave "a huge mark on land that we're trying to conserve."

Spain's Solar-Power Collapse Dims Subsidy Model

BY ÁNGEL GONZÁLEZ AND KEITH JOHNSON

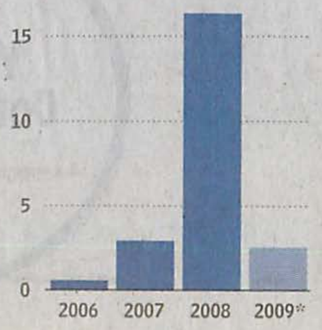
Spain's hopes of becoming a world leader in solar power have collapsed since the Spanish government slammed the brakes on generous subsidies.

The sudden change has rippled across the global solar industry, in a warning of the problems that government-supported renewable-energy programs can encounter.

In 2008, Spain accounted for half the world's new solar-power installations in terms of wattage, thanks to government subsidies to promote clean energy. But late last year, as the global economic crisis worsened, the government dramatically scaled back those subsidies and capped the amount of subsidized solar power that could be installed.

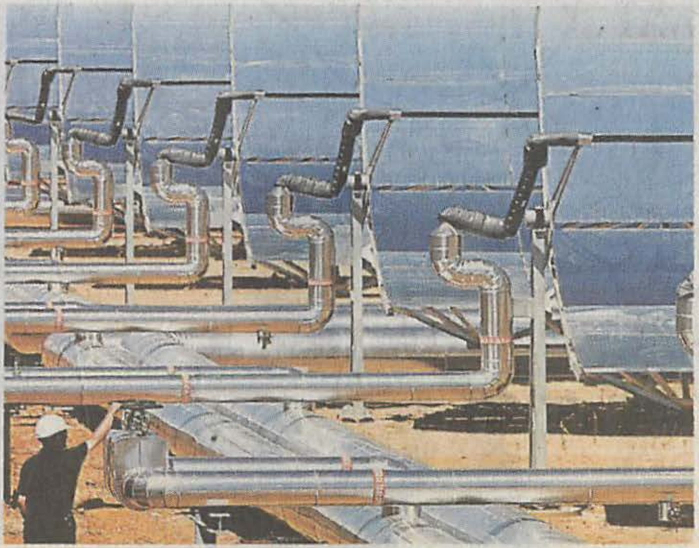
Cloudy Outlook

Size of Spain's photovoltaic market, in billions of euros



A solar power plant in Alvarado ▶

* Estimate; €1 billion =$1.4 billion; Source: Asociación de la Industria Fotovoltaica



Reuters

Factories world-wide that had ramped up production of solar-power components found that demand for solar panels was plummeting, leaving a glut in supply and pushing prices down. Job cuts followed.

"The solar industry in 2009 has been undermined by [a] collapse in demand due to the decision by Spain," says Henning Wicht, a solar-power analyst at research group iSuppli.

Spain is providing important lessons for the U.S., where lawmakers are engaged in a debate about how to support renewable energy. Boosters of clean energy, including President Barack Obama, have pointed to Spain as a success story showing how government policies jump-started renewable energy, created new industries, and helped the environment.

Spain's early bet on wind power paid off: The country is one of the world leaders in generating such power, only recently eclipsed by the U.S. Spanish wind-power companies have become global players. In 2008, wind power accounted for 11% of Spanish electricity production, compared to less than 1% for solar power.

Reyad Fezzani, chief executive of BP Solar, a unit of oil giant **BP** PLC, said that despite the current crisis, the Spanish model succeeded in creating a solar industry from scratch. "Once you pay for the infrastructure, you have a skilled work force and you can expand and contract very easily," he said.

Clean-energy skeptics, however, point to Spain as a cautionary tale of a government policy that created a speculative bubble with disastrous consequences. Some Republicans have cited Spain's solar bubble and bust as an example of how unsustainable government clean-energy pushes are.

The U.S. is experimenting with different ways to promote clean energy, including tax incentives and direct federal subsidies to defray installation costs, and mandates for utilities to get a certain amount of their power from renewable energy.

California and New Jersey, which lead the U.S. in solar power, are among states that have used Spanish-style subsidies to make solar power more attractive. Two House Democrats, Jay Inslee of Washington and Bill Delahunt of Massachusetts, are drafting legislation under which electricity generated by solar panels and other clean energy sources would be bought by utilities at a fixed price.

The industry's fundamental problem is that, without subsidies, it's still not economically viable.

Mike Ahearn, chief executive of Tempe, Arizona-based **First Solar** Corp., says solar power could be competitive "within a couple of years"—but only if the industry gains scale. That would require generous government subsidies and other forms of support, Mr. Ahearn says: "It's a chicken-and-egg problem."

Spain's solar ambitions started as an outgrowth of the earlier push to become a global player in wind power. By offering generous long-term support for wind power, Spain became a world leader. Companies such as **Iberdrola** SA and **Gamesa** Corp. catapulted from their home market to the U.S.

Wind energy was a cheaper renewable option than solar, so the Spanish government sought to make solar power more attractive by increasing subsidies, just as other countries, particularly Germany, were scaling back support.

As a result, Spain's solar capacity last year increased to 3,342 megawatts from 695 megawatts, the size of a coal plant, a year earlier. Government subsidies for solar power jumped to €1.1 billion ($1.6 billion) in 2008 from €214 million in 2007.

Solar power "was a financial product, not an energy solution," says Ignacio Sánchez Galán, chairman of Iberdrola, the world's biggest renewable-energy company. Iberdrola has largely shunned solar because wind power is cheaper and requires less land.

That's especially true of the new wave of large-scale solar power, known as solar thermal power, which uses the sun to heat water into steam which runs turbines. That technology offers the potential for much bigger clean-energy projects than silicon-coated photovoltaic panels, and has attracted interest from utilities in Spain and the U.S., especially. But solar thermal power is far from being cost-competitive with traditional power sources, and it requires large swathes of empty land, such as those found in parts of Spain and the U.S. Southwest.

Faced with the unraveling world economy and a deepening budget deficit, the Spanish government late last year reduced the money it paid for solar electricity and capped the amount of subsidized solar power installed each year at 500 megawatts. Spain's solar-power capacity has actually shrunk this year as a result.

The effects have been felt far beyond Spain. China's **Yingli Green Energy Holding** Co., which makes solar-power components for export, posted a 43% slide in first-quarter earnings, in large part because Spain was no longer buying.

Solar makers such as Norway's **Renewable Energy** Corp., China's **LDK Solar** Co. and **JA Solar Holdings** Co. posted big second-quarter losses. German giant **Q-Cells** SE posted a first-half net loss of €697 million and plans to cut about 500 workers—about a fifth of its work force.

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Solar and Wind-Power Proposals Draw Opposition From Residents Fea

Technology changes, but human nature doesn't. Environmentally friendly energy projects are running into the same cries of "not in my backyard" that stymied a previous generation of alternative-power efforts.

Even as Americans tell pollsters they are eager for alternatives to fossil fuel, some are fighting proposals for solar and wind projects and for the thousands of miles of transmission lines that would be needed to carry the cleaner energy to market. The protests echo grassroots opposition that has blocked nuclear plants and energy-producing trash incinerators for decades.

POWER SHIFT

By Jeffrey Ball

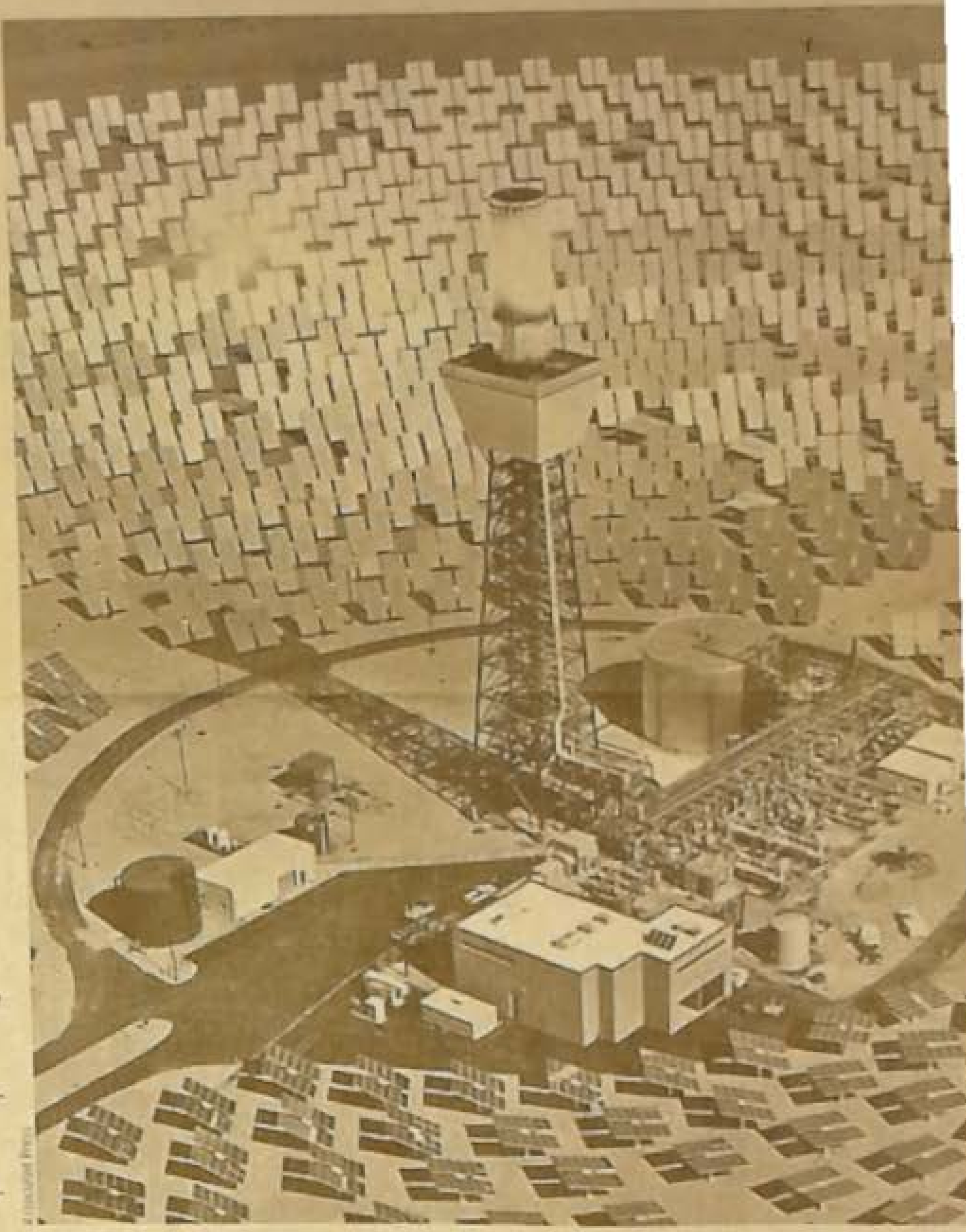
The new backlash is fueled by worries that renewable-energy projects would occupy vast amounts of land to produce significant amounts of power. Either renewable projects would have to be centralized and sprawling, covering many square miles apiece, or they would need to be distributed in pieces across millions of rooftops and lawns.

Renewable-energy projects would reduce pollution and combat climate change. The trade-off is that many more people would have to see wind turbines, solar panels and other energy infrastructure near their homes in order to diminish the need for coal mines and other fossil-fuel facilities.

"Anywhere I walked on this property, we'd be able to view them and we'd be able to hear them," says Tina FitzGerald, who lives with her family on a 12-acre Vermont farm near where a developer has proposed erecting five wind turbines, each about 400 feet tall. "There should be a place for these—someplace that isn't going to impact families quite so much."

In California, which is considering a goal of producing a third of its electricity from renewable sources by 2020, some residents are fighting proposals to build vast solar-energy plants in the Mojave Desert, one of the most remote and reliably sunny spots in the U.S. Up and down the East Coast, meanwhile, residents are opposing plans for wind farms, fearing they will mar views and lower property values.

Americans aren't alone in their skittishness. In the U.K., which also aims to generate about one-third of its electricity from renewable sources by 2020, local opposition is holding up proposed wind projects.



Proposed renewable-energy projects have been drawing opposition from people who worry ab

Resistance in Ontario led the Canadian province to pass legislation in May establishing a framework for locating renewable-energy sites; local opponents will be able to challenge projects on environmental or safety grounds, but not for aesthetic reasons.

In a report last year, the Paris-based International Energy Agency cited "not in my backyard" sentiment as among the top five threats to the growth of renewable energy world-wide.

The U.S. has to make a tough choice, says Jason Grumet, president of the Bipartisan Policy Center, a Washington think tank that supports giving the federal government more authority to push renewable-energy projects forward. That will be necessary, he says, to curb the country's dependence on foreign oil and its greenhouse-gas emissions. "You have to ask yourself: At what point do priority national interests need to override local goals?"

The clash over whether it is more important to produce nonpolluting domestic energy or to protect environmentally valuable places poses a dilemma for some longtime activists.

Calvin French, a 72-year-old retired high school English teacher, has belonged to the Sierra Club all his adult life. Leaders of the environmental group are working with California officials to help pick sites for big renewable-energy transmission lines as a way to combat climate change. But many club members, including Mr. French, want to protect their favorite places.

His battlefield is the Carrizo Plain, a 460-square-mile swath of grassland about 115 miles north of Los Angeles that is traversed by the San Andreas Fault.

The parched, rugged expanse is home to species including the endangered kit fox and the antelope-like pronghorn. It also is one of the most alluring spots for solar panels in the nation's most populous state. There is prolific sunlight. Much of the land has been subdivided into farms, meaning that acreage no longer can be defended as untouched. And there is a high-voltage line nearby, with capacity to carry solar powe

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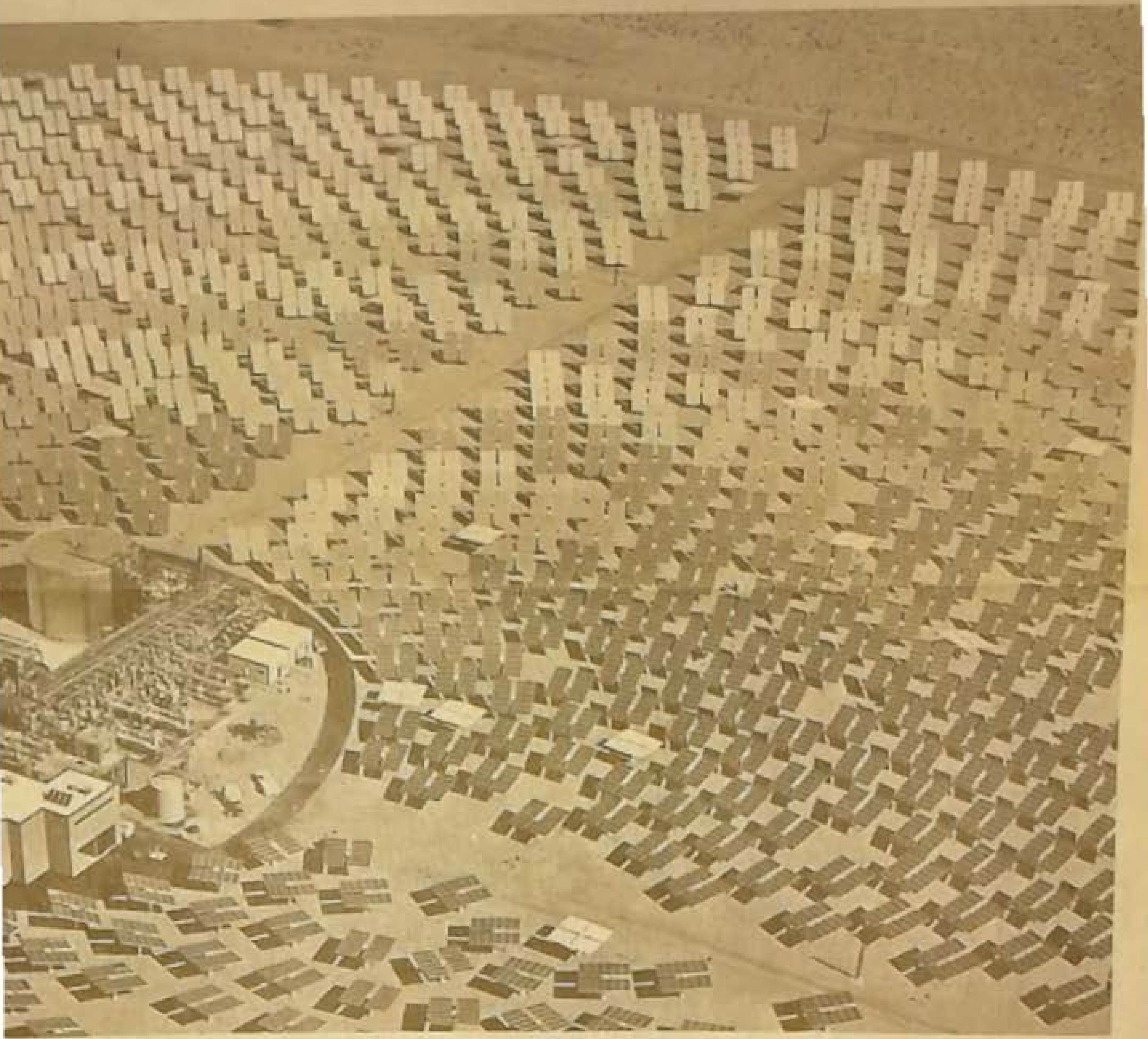
Meet the New Nimbys

Residents Fearing Visual Blight; a Dilemma for Some Environmentalist



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Amid local opposition, county and state officials for months have been mulling three big solar-energy projects that together would amount to some of the biggest solar arrays in the world.

"Big things like global warming" are difficult to understand, says Mr. French. "But you can go out into a beautiful place and say, 'This needs to be protected.' That's easy to understand."

Around the world, countries that have rolled out fossil-fuel alternatives most aggressively have used heavy-handed government action to address such sentiment. France, for example, now produces about 80% of its electricity from nuclear energy. But France's national government manages the country's nuclear-construction program, and it has pushed ahead for decades despite sometimes-heated public protests.

Lawmakers in the U.S. Congress now are fighting over how much power the federal government should have in getting energy projects built. Many renewable-energy proponents say a massive network of new transmission wires would have to be built to bring large supplies of renewable power to population centers. A Senate committee passed a bill in June that would give the federal government authority to decide where to put new power lines if states, which now make those decisions, move too slowly.

The drive for more federal control has the support of many executives in the electric industry, who say the new transmission lines should be available for energy from all sources, including fossil fuel. But there is plenty of opposition to giving Washington that power. Some lawmakers from densely populated states don't want big new transmission lines running through their land. Many state utility regulators also object to an increased federal push.

Caught in the middle are states where renewable energy suddenly is big business. Wyoming Gov. Dave Freudenthal likens his state's wind boom to the coal rush that hit Wyoming three decades ago in the wake of an energy shock.

At a wind-energy conference in Wyoming last month, Gov. Freudenthal, a Democrat, delivered a stern warning to wind-turbine developers, telling them to make sure their projects don't harm a small bird called the sage grouse.

"What I have is an obsession with making sure that the economy of this state continues to function, and it won't if that bird gets listed," according to his office's transcript of his remarks.

Anything that nudges the sage grouse toward the federal government's list of endangered species, he explained, would trigger land-use restrictions that would jeopardize Wyoming's main economic engine: the production of coal, oil and natural gas. "Generally in this state, we support economic development," he told the wind developers. But "when all of a sudden it ends up in our backyard, our view changes a lot."

Jeffrey Ball responds to reader questions at WSJ.com/Currents. Email him at powershift@wsj.com.