FLORIDA SOLAR ENERGY CENTER®

Solar Energy in Florida

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The race is on to deal with global problems

To understand Florida's position in the development of solar technologies it's necessary to visualize a bigger picture. Currently, the United States spends over $38 billion per year for crude oil and petroleum product imports, whereas appropriations for research and development on solar energy technology total less than $120 million per year.

Florida is the fourth largest state with over 12 million residents. In 1988 its population increased by nearly 330,000 and its energy bill was over $16 billion dollars. Since Florida is heavily dependent upon energy-intensive tourism for economic stability and since the state also enjoys abundant sunshine, it should vigorously pursue the development of solar energy technologies offering the greatest benefits to its residents.

Not only do we operate within a global economy, we also operate within a global environment. If the greenhouse effect and global climate change force nations to drastically reduce carbon dioxide emissions, there are very few alternatives to fossil fuels for power production. In a world of dwindling energy resources, solar technologies are a bright if lonely beacon.

Current uses of energy by sector in Florida and the United States*

Sector	Florida	U.S.
Transportation	35.9%	27.9%
Residential	26.0%	20.5%
Commercial	20.5%	15.7%
Industrial	17.7%	35.9%

*1987 estimate: U.S. Department of Energy

Will the United States be left behind?

Historically, the United States has been a leader in research and development (R&D). In the alternative energy research and development arena however, we are in danger of being outdistanced by foreign competitors.

For example, Germany and Japan already have larger hydrogen R&D programs. Hydrogen cars are being tested and production is being planned. Solar-produced hydrogen is being developed for heating, cooling and fuel cell electricity for homes.

Additionally, some American photovoltaic cell production companies, once at the cutting edge, may sell out to the highest bidder, even if it's from another country. And Japan is now producing more photovoltaic modules than is the United States.

The energy/economy/environment problem is the most complex and interrelated one ever addressed. Ignoring existing technologies and delaying research in promising areas will not only prolong the problem, it will also exacerbate it.

Solar energy works now

Cold realities are prompting a fresh look at existing strategies.

Residents of south Florida used *solar water heating* as far back as the turn of the century. In the 1930s, one out of almost every two new houses in south Florida had a solar water heating system installed. By 1950 there were an estimated 30,000 to 50,000 units. However, their popularity began to wane when electrical energy became cheap and readily available.

Now, in view of renewed energy concerns, and considering that about 80 percent of Florida homes have electric water heaters, solar water heaters are once again a hot item. They are simple, commercially available and economically competitive with electric water heaters.

Approximately 250,000 domestic solar water heaters are saving about 500 million kilowatt hours of electricity in Florida each year. A

family of four can save as much as $300 per year in electric bills by installing one. An added benefit is that Florida exempts such systems from property tax.

At present, an installed solar water heater costs between $2,000 and $3,500. The quality of flat-plate solar collectors for water heating has improved dramatically over the past decade, both in performance and workmanship. Furthermore the collectors and complete systems manufactured or sold in Florida must meet standards developed by the Florida Solar Energy Center (FSEC).

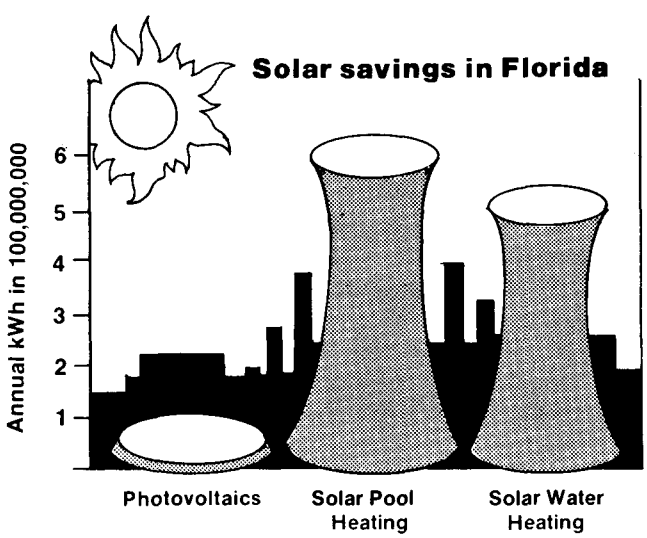
Solar pool heating is progressing swimmingly in Florida. Currently about 100,000 solar pool heaters are installed with savings amounting to approximately 52,000 cubic feet of natural gas annually. As a substitute for electrical heating, solar savings amount to 600 million kilowatt hours per year.

To maintain comfortable temperatures, a typical residential pool requires 50 million Btus per swimming season. Individual annual savings by using solar heating in place of fossil fuels range between $300 and $800, depending upon the type of fossil fuel used.

The average commercially built and installed residential solar pool heater costs between $2,500 and $3,500 with an expected payback period of from two to four years. Like solar water heaters, all solar pool heaters manufactured or sold in Florida must meet standards developed by FSEC.

The market potential for further growth of solar pool heating is great, thanks to the large number of pools in the state and a steadily growing population to enjoy them.

FSEC research on solar systems for schools and commercial-sized pool heating makes them attractive options, too.



Space cooling accounts for about 33 percent of residential energy use in Florida. With this in mind, it makes sense to develop solar cooling technology, since the solar resource is most available at the time when the need is greatest for air conditioning.

Most solar thermal cooling systems are not yet cost effective. However, FSEC is investigating innovative air-conditioning systems that increase system efficiency and decrease overall energy consumption.

This research centers around cooling systems that use heat pipes, fresh-air dehumidification, thermal storage, and absorption technology. FSEC's desiccant-enhanced radiative cooling and dehumidification project (DESRAD) aims to find a practical way in which solar energy can keep Florida buildings cool and dry.

The Center is also concerned with and is investigating ways to improve the efficiency of air conditioners, and to decrease their peak load and energy consumption.

Solar cooling through the use of photovoltaic cells to generate electricity to drive conventional air conditioners will be an increasingly attractive option as the cost of the cells continues to come down.

Passive solar and *low-energy building design* techniques can be effective even in a hot, humid climate such as Florida's. The objective is to work with the environment to achieve desirable comfort levels with as little reliance on mechanical equipment as possible.

Passive cooling involves a combination of heat-gain prevention techniques, heat-rejection strategies, and the proper use of thermal and moisture storage materials in the building design.

Factors such as siting of buildings, location and choice of windows, use of radiant barriers and strategic landscaping contribute to the total passive cooling package. FSEC continues its research into more and better passive design concepts.

Photovoltaics (solar electricity)

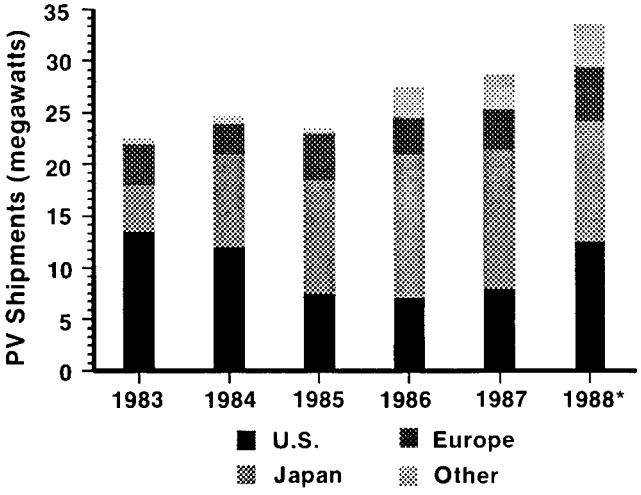
Photovoltaics (PV), or solar cells, generate electricity directly from sunlight without any fuel costs, moving parts, noise or harmful emissions.

Photovoltaics currently provides many examples of real energy savings in Florida. Utility installations, state-funded demonstrations and residential systems amount to about 200 kilowatts of installed PV capacity in the state. That adds up to around 400,000 kilowatt hours of electrical production annually.

The technical feasibility and reliability of PV

have been proved through the space program's use of cells to power satellites. Research continues to decrease production costs, increase cell efficiencies and improve energy storage options — the barriers to widespread use of photovoltaics.

The impact of photovoltaic R&D



* Estimated

Source: U.S. Department of Energy

Fortunately, PV is economically competitive in more and more markets as its cost goes down relative to other ways of accomplishing the same objective. With advances in production techniques the price of solar modules, which were over $200 per peak watt when first introduced in the space program, are currently around $5 per peak watt.

Present stand-alone and remote applications include water pumping for irrigation; communications relay stations; cathodic (corrosion) protection of bridges; lighting for marine, park and highway use; and medical vaccine storage.

Additionally, more and more consumers are enjoying the convenience and economy of consumer-oriented products such as street and walkway lighting and security systems, as well as the familiar calculators and watches that are powered by PV cells.

The three major areas of photovoltaic research at FSEC are:

- Stand-alone applications
- System configurations
- Testing of thin-film modules.

PV cost for Florida:

	Present	1990s	Year 2000	Cell efficiency
Array cost $/Wp	$5.0/Wp	$1.7/Wp	$0.45/kWp	14%
Systems cost $/Wp	$6.6/Wp	$2.6/Wp	$0.88/Wp	16%
Electric cost (life cycle) $/kWh	$0.35/kWh	$0.12/kWh	$0.03/kWh	20%

NOTE: Wp (peak watts) refer to electric power produced at solar noon.

Energy from hydrogen

Hydrogen, the power behind the Space Shuttle, has been called the perfect fuel. It is the most abundant element on earth; it can be derived from renewable resources; it produces no carbon pollutants. The challenge is to develop cost-effective methods to produce, store and use the fuel.

Energy is needed to extract hydrogen from those elements with which it is naturally combined. Solar-powered production is one of the most attractive methods currently being investigated.

Hydrogen can be produced using fossil-based resources; but fossil resources are limited, and their resulting by-products are the same ones currently polluting the environment. Photovoltaic electrolysis and other photo-enhanced processes appear to be appropriate, clean technologies for producing hydrogen by separating it from its co-elements.

At FSEC, current efforts focus on increasing the efficiency of PV electrolysis and photoelectrochemical production methods and on developing safe and suitable means of storing hydrogen. In the utilization area, FSEC is addressing transportation considerations, as well as fuel cells.

In the transportation sector, it is essential to immediately undertake a program to consider all alternative fuels and power sources — methane, methanol, hydrogen and electricity. Hydrogen-fueled vehicles would be a boon to Florida, since the transportation sector currently accounts for about 36 percent of the state's total energy consumption and 75 percent of Florida's petroleum consumption.

FSEC has mounted a major hydrogen research initiative with alternative fuel systems as the goal. In the final analysis, only hydrogen produced from renewable resources can meet our long-term power and environmental concerns. Only by producing the hydrogen fuel of the future

from renewable resources can we ensure that its production does not create as many problems as it solves.

Other solar applications

Agriculture is the world's greatest user of solar energy for human needs, with about 11 percent of the land area under permanent crops.

Agricultural applications of solar energy, most of which need relatively low temperatures, include heating and cooling of greenhouses and fish farms, food processing, grain drying, crop drying, and heating of livestock shelters. Another important application is PV-powered water pumping.

Biomass resources, which, by definition, come from any organic matter other than fossil fuels, are a means of producing energy. They include municipal waste, manure, forestry and crop residues, industrial waste, special energy crops and aquatic farming crops. Mounting landfill problems are making the use of waste for energy more and more attractive.

Other solar technologies and applications are either not as well suited to Florida's climate or will not be practicable for some time. These include wind power, solar thermal electric production and ocean thermal energy conversion.

Conclusions

The contribution of the solar field to an improved global economy and environment is already significant, yet its full potential is nowhere near realization. For instance, it is essential to consider the contribution of solar water and pool heating and to promote these technologies, not just for their intrinsic benefits, but as a springboard for further work in lesser known and less developed areas.

Among those technologies to which FSEC sustains a serious commitment are:

1. Photovoltaics
2. Passive solar and low-energy building design
3. Domestic water and pool heating for residential and commercial applications
4. Hydrogen energy from renewable resources.

Public awareness and acceptance of near-term solar technologies will have a positive influence on other solar research projects and on energy conservation practices in general.

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U.S. Department of Energy, **Photovoltaics Energy Program Summary, Volume I, Overview FY 1988,** by Solar Technology Information Program, SERI, Golden, CO, January 1989.

Resources

Conservation and Renewable Energy Inquiry and Referral Service
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Florida Solar Energy Industries Association
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The Florida Solar Energy Center distributes over 300 free publications that offer more information on these and other energy-saving techniques. They include:

Solar heating of swimming pools: A question and answer primer, by Charles Cromer. Order No. EN-6.

Solar water heating options in Florida, by John Harrison and Tom Tiedemann. Order No. EN-9.

Photovoltaics: A question and answer primer, by Ingrid Melody. Order No. EN-11.

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