

Chapter One

Introduction

Solar energy is an abundant, renewable resource that can meet many of our energy needs here in Kentucky. It can be used to generate electricity; to heat water for bathing, washing, space heating, and other purposes; to cook and dry food; and to purify water. Through passive solar building strategies, the sun's energy can heat and cool buildings and provide daylighting. Solar energy can meet a substantial portion or even all of a home's energy needs, greatly reducing monthly utility bills. For the Commonwealth and our nation, investing in solar energy could increase our independence from foreign energy sources and polluting forms of energy.

The need to develop clean, sustainable energy sources is imperative. The use of conventional energy sources, especially fossil fuels and nuclear power, incurs widespread environmental and human health costs. Disruptions to the global climate, international conflict, and the spread of nuclear materials that could be used as weapons are among the results of our dependence on these conventional fuels. Freeing ourselves from this dependence will give us cleaner air and water, healthier families, communities, and environments, and increased security from nuclear accidents and terrorist attacks.

Solar energy is one of the key components of a safer, healthier, more sustainable energy economy. It provides greater independence and energy security, protecting its users from interruptions to the power grid and fluctuating fuel prices. On a regional and national level, solar energy systems could become part of a "distributed energy network" in which many thousands of smaller and decentralized energy producers would make the whole system less vulnerable to interruption. By developing the use of solar and other renewable resources, our nation becomes less dependent upon foreign sources of energy. This reduces the justification for using the military to protect our fuel supplies in foreign lands, allowing all of our resources to be used more wisely and profitably.

Solar energy is widely used around the world in climates as diverse as northern Europe and southern California. Solar photovoltaic technology has developed rapidly over the past four decades, with prices falling dramatically and global installations growing at a rate of 30 percent per year over the past five years.¹ Solar water heating technologies have been in widespread use for the past century. Countries such as Israel and

Japan have witnessed a consistently increasing use of the technology. Tokyo had over 1.5 million solar water heaters in use in 1991 and Israel now requires solar water heaters in all new buildings.² Global experience has shown that the use of solar is not limited to the sunniest climates, and that it is capable of making a significant contribution to meeting the world's energy needs.

Despite its many advantages, solar energy is still in competition with very cheap energy in places such as Kentucky. For most people, solar photovoltaics (PV) remain the most expensive option for providing electricity. Solar water heating systems, which usually produce substantial long-term financial savings, have a higher up-front cost than conventional water heaters. These economic realities have hindered the growth of the solar industry and the use of these technologies in Kentucky. However, higher energy prices or the availability of financial incentives to off-set solar's higher up-front costs can shift the economics enough to make solar economically competitive. These forces have helped drive the growth of the solar industry in California and Europe, and as the industry has expanded, prices have come down, making solar even more competitive.

Even in Kentucky the economic comparison can favor solar. Solar electricity is often the least-costly option at sites more than $\frac{1}{4}$ mile from the nearest utility line. In these situations the cost of running a new power line can exceed the cost of installing a solar electric system. In the case of solar water heaters, the energy savings they produce can pay for the cost of the system in as little as five to ten years. The economic returns are even better for homes and facilities that use high volumes of hot water. Once a solar water heater is paid for, its energy savings are like tax-free income and can amount to hundreds of dollars per year. Solar energy systems also insulate their owners from rising fuel prices for decades to come, while providing greater independence and self-sufficiency.

The Importance of Energy Efficiency and Conservation

The development of a clean, sustainable energy system depends as much on energy efficiency and conservation as on the development of renewable energy sources such as solar. Improved efficiency enables us to do the same or more work while using less

energy. Through conservation, we find alternate ways of doing things that reduce our energy demands. Efficiency and conservation allow us to meet our needs at a lower cost and with less pollution. This principle applies nationally and at the personal level. Nationally, investing in energy efficiency is like building power plants that don't pollute, at a fraction of the cost. For example, a report from the Alliance to Save Energy states that if all homes in America used the most energy efficient refrigerators available, the electricity savings would eliminate the need for about 30 power plants.³ Those energy savings would translate into pollution not produced and money saved by American families.

Achievements of the Federal Energy Management Program (FEMP) illustrate the enormous potential of energy efficiency. According to the Alliance to Save Energy, the FEMP has saved taxpayers more than \$8 billion through energy efficiency in government buildings. The further installation of currently-available, cost-effective technologies could save U.S. taxpayers an additional \$1 billion per year.⁴

Energy efficiency offers tremendous opportunities at the personal level, as well. Compact fluorescent light bulb's (CFL) produce the same amount of light as standard incandescent bulbs, but use 25 percent as much energy (see Table 1.1).⁵ High-efficiency models are now available for most appliances, and can be identified by the Energy Star label. The benefits to consumers from the move to efficiency are illustrated by the air conditioner efficiency standards approved in 2004, which are expected to save American consumers \$5 billion in energy costs over the next 25 years.⁶

To minimize the up-front costs of solar energy systems, begin with energy efficiency and conservation. It is much less expensive to invest in energy efficiency than to buy an over-sized solar system, so spend your first energy dollars on efficiency and conservation.

Start by reviewing all the ways you use energy. Figure out how you can reduce your demand or find alternate ways to meet your energy needs before selecting a system. A good rule of thumb before installing a solar system is to first cut energy consumption by two or three times. For instance, when considering solar lighting, use as much daylighting as possible during the day, then use only fluorescent lighting at night, since fluorescent lighting usually uses 1/3 or 1/4 as much electricity as incandescent lighting. When solar-powering computers, switch first from desktop units to notebook models, since laptops usually use 1/4 to 1/8 as much electricity.

Also consider what you need the energy for. This will guide you to the appropriate type of solar technology and will help you use your resources most wisely. For example, to heat your home, electric resistance heaters powered by solar photovoltaic panels would be a very poor and expensive choice. This is because electricity is the least efficient means of generating heat, and photovoltaic panels convert only 10 to 15 percent of the sun's energy into electricity. Solar water heater collectors, meanwhile, capture and transfer the sun's heat energy efficiently and cost-effectively, and are well-suited for use in home heating systems. Therefore, if you're considering how best to heat your home, look instead into solar water heaters, passive solar design strategies, and active solar space heaters. This approach will help you get the most from your solar system and the money you invest in your energy needs.

Passive Solar Building Design

Solar energy can be used effectively and economically to provide space heating, cooling, and lighting for homes and other building types. Through passive solar building design, buildings capitalize upon the freely available solar resources at a given site,

Table 1.1: Comparing Incandescent and Compact Fluorescent Light (CFL) Bulbs

Bulb Type	100W Incandescent	23W Compact Fluorescent
Purchase Price	\$0.75	\$11.00
Lumens (light output)	1,690	1,500
Life of Bulb	750 hours	10,000 hours
Number of Hours on Per Day	4 hours	4 hours
Number of Bulbs Needed	5.84 (6) over 3 years	1 over 6.85 years
Total Cost of Bulbs	\$4.50	\$11.00
Total Cost of Electricity over 3 Years (@ 6.5 Cents/kWh)	\$28.47	\$6.55
Total Cost over 3 Years	\$32.97	\$17.55
Total Cost Savings over Three Years using a CFL in place of an Incandescent Bulbs- \$15.42		
Total Cost Savings over Three Years if Five Incandescents are replaced with CFLs- \$77.10		

Power\$mart, by the Alliance to Save Energy and U.S. Department of Energy, Energy Information Administration.

Steps to Choosing a Solar Energy System

The following chapters illustrate that there are many ways to utilize solar energy. To choose the appropriate type of solar energy system, ask yourself the following questions:

1. What do I need the energy for? Heating, lighting, water heating, powering appliances, or other needs?
2. How will the energy be used, specifically? Study your patterns of energy use. The way you use energy and the appliances you use will influence the type of solar technology you should employ. For example, if you need light in a workshop where you mainly work during the day, maybe a well-placed window to provide daylight would work just as well- and be cheaper- than a solar electric system to power electric lights.
3. How can I reduce my energy demand through efficiency, conservation, and behavior changes? When you study how you use energy, you begin to discover many opportunities for reducing waste and doing things more efficiently. Applying efficiency and conservation measures will reduce your energy demand, while still enabling you to do the things you need to do. This will save you money right from the start, while also reducing the cost of whichever solar energy systems you choose to use.
4. What solar technologies and strategies will best meet my energy needs?

Now you are ready to choose among the various solar systems and design strategies.

reducing the need for external heat sources. Proper design can also substantially reduce the need for electric lighting during the day, through the use of natural daylight.

These design strategies are part of a broader approach known as *climate responsive design*, which understands buildings within their local context. Through this approach, buildings are designed to suit the local climate and utilize the resources available on-site. These resources include wind, vegetation, topography, water, soil, the earth's capacity to moderate temperatures, and solar energy. Integrating all of these resources into the building design can effectively assist with heating, cooling, and lighting, reducing the need for external energy sources. This approach can also produce a more functional and beautiful home.

A complete discussion of daylighting and passive solar building design is beyond the scope of this Guide and numerous resources already exist to assist with the design of passive solar buildings. For new building construction and many renovation projects, passive solar design makes enormous sense. Whether you are planning to build a new home or commercial building, or trying to improve the energy efficiency and comfort of an existing building, we encourage you to learn more about passive solar design and apply its principles on your projects. Please refer to the Resources section on page five to learn more about this topic.

Layout of the Guide

The first two sections of *The Kentucky Solar Energy Guide* provide an introduction to solar energy technologies. Section One addresses solar electric (photovoltaic) systems, including general information related to solar system design, relevant to many solar energy technologies, including photovoltaic systems

(see Chapter Five, Designing Solar Electric Systems). Section Two, Solar Thermal Technologies, discusses many of the ways the sun's heat energy can be harnessed to do useful work. This section emphasizes solar water heating systems (including solar swimming pool heaters), and also includes active solar air heating, solar cooking and food drying, and solar water purification. Both sections are interspersed with case studies of solar energy systems in use in Kentucky.

Section Three provides a guide to resources that can help you find the support you need to use solar energy at your home, farm, or business. Chapter Thirteen discusses incentives that support investments in renewable energy and energy efficiency within Kentucky. Chapter Fourteen presents guidelines for choosing a solar energy installer, offering advice for making wise decisions when contracting professionals to work on your home. Chapter Fifteen presents the

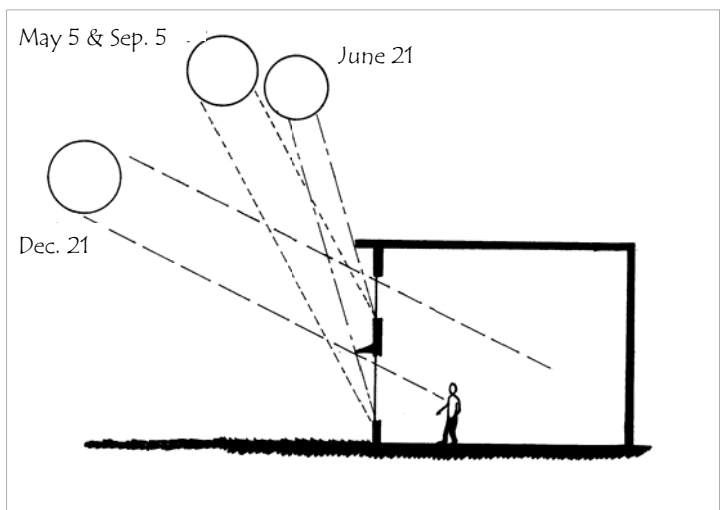


Figure 1.1: Awnings and roof overhangs can be used to control the sunlight that enters a building, an important element in passive solar design, *Andy McDonald*

Kentucky Sun Pages, a directory of renewable energy and green building businesses and professionals serving Kentucky. The Sun Pages connects those seeking to install solar systems or build with environmental protection in mind to installers, professionals, and businesses skilled in these fields. In Chapter Sixteen you will find a list of suppliers, manufacturers, and retailers of renewable energy products and equipment.

Each Section includes lists of references to publications, websites, and organizations where you can learn more about each of the topics discussed in this Guide.

End Notes

1. Joel Makower, Ron Pernick, and Clint Wilder, "Clean Energy Trends 2004," *Clean Edge*, March 2004. Available at: www.cleaneedge.com/reportstrends2004.php
2. Daniel M. Berman and John T. O'Connor, *Who Owns the Sun? People, Politics, and the Struggle for a Solar Economy*, 1996, Chelsea Green Publishing Company, White River Junction, Vermont.
3. *PowerSmart*, 2002, Alliance to Save Energy, Washington, DC.
4. Alliance to Save Energy, Washington, DC. On-line fact sheet available at: www.ase.org/programs/federal/femp.htm
5. Adapted from *PowerSmart*.
6. American Council for an Energy-Efficient Economy, Washington, DC. On-line fact sheet. URL: www.aceee.org

RESOURCES:

Energy Efficiency and Conservation

Publications

Consumer Guide to Home Energy Savings, A. Wilson, J. Thorne, and J. Morrill, ACEEE, Washington, DC, 2003. The Consumer Guide will help you find energy-saving products and show you how to use them most effectively. From light bulbs to furnaces, air conditioners to washing machines, windows to refrigerators, all are covered in this guide for consumers who care about the environment and about their budget. Can be purchased on-line at: www.aceee.org

"Home Energy Briefs," Rocky Mountain Institute, Snowmass, Colorado, 2004. These nine reports address energy efficiency and conservation in the following areas: building envelope, lighting, space cooling, space heating, water heating, cleaning appliances, electronics, kitchen appliances, and whole system design. Free downloads available on-line at: www.rmi.org/sitepages/pid194.php

Home Energy Magazine, see below for contact info.

The Most Energy Efficient Appliances 2004, ACEEE, Washington, DC, 2004. A listing of appliances based on product directories and manufacturers' data regarding energy performance. Available at www.aceee.org

Southface "Fact Sheets" and "Technical Bulletins," Southface Energy Institute. These Fact Sheets and Technical Bulletins cover a wide range of topics and provide extensive information related to energy efficient, environmentally-sound, high performance home building. They can be downloaded for free from their website, www.southface.org

"What You Can Do to Save Energy and Money: A Checklist for Action," ACEEE, Washington, DC. Available on-line at www.aceee.org

Organizations

American Council for an Energy-Efficient Economy

1001 Connecticut Avenue, NW

Suite 801

Washington, DC 20036

(202) 429-8873

www.aceee.org

The American Council for an Energy-Efficient Economy is a nonprofit organization dedicated to advancing energy efficiency as a means of promoting both economic prosperity and environmental protection. Publishers of the *Consumer's Guide to Home Energy Savings* and *The Most Energy Efficient Appliances 2004*.

Energy Efficiency and Renewable Energy Network

(800)DOE-3732

www.eren.doe.gov

EREN provides an enormous database and search engine on all aspects of energy efficiency and renewable energy. The web site provides access to a wealth of information about renewable energy and energy efficient technologies.

Energy Star Products and Programs

(888)STAR-YES

www.energystar.gov/

The U.S. Environmental Protection Agency and the Department of Energy promote the purchase and use of energy-efficient appliances and equipment by awarding the Energy Star label. Their web site includes program descriptions, product specifications, lists of qualifying products and manufacturers, news and updates.

Home Energy Magazine

2124 Kittredge St., #95

Berkeley, CA 94704

(510) 524-5405

www.homeenergy.org

Home Energy Magazine is dedicated to housing quality, comfort, and energy efficiency. The Home Energy web site includes an index to all feature articles, some full articles, and energy links.

Rocky Mountain Institute
1739 Snowmass Creek Road
Snowmass, CO 81654-9199
(970)927-3851
www.rmi.org

RMI is a national leader in the field of energy efficiency. Among their many excellent publications are their *Home Energy Briefs* (see Publications list above).

Southface Energy Institute
241 Pine St. NE
Atlanta, GA 30308
(404)872-3549
www.southface.org

The Southface Energy Institute works to promote environmentally sustainable homes, workplaces and communities through education, research, advocacy and technical assistance. Their *Fact Sheets* provide extensive information related to energy efficient, environmentally-sound, high performance home building, and can be downloaded for free from their website.

RESOURCES: Passive Solar Heating, Cooling, and Daylighting

Publications

Direct Use of the Sun's Energy, F. Daniels, Yale University Press, New Haven, 1964.

Heating, Cooling, Lighting: Design Methods for Architects, N. Lechner, Wiley Publishers, 2000.

"Passive Solar Design," Technical Bulletin published by Southface Energy Institute and the Office of Building Technology, State and Community Programs, U.S. Department of Energy. No date. Available online at: http://www.southface.org/web/resources&services/publications/factsheets/sf_factsheet-menu.htm

The Passive Solar Design and Construction Handbook, Michael J. Crosbie (ed.), Wiley Publishers, 1997.

The Passive Solar Energy Book: A Complete Guide to Passive Solar Homes, Greenhouses, and Building Design, Edward Mazria, Rodale Press, 1979.

The Passive Solar House, James Kachadorian, Chelsea Green Publishing Company, 1997.

The Solar House: Passive Heating and Cooling, Daniel Chiras, PhD., Chelsea Green Publishing Company, 2002.

Sun, Wind & Light: Architectural Design Strategies, G. Z. Brown and M. DeKay, Wiley Publishers, 2000.

Organizations

North Carolina Solar Center
Box 7401
North Carolina State University,
Raleigh, NC 27695-7401
(919)515-5666
www.ncsc.ncsu.edu/

The North Carolina Solar Center offers numerous publications addressing passive and active solar energy. These documents can be downloaded for free from their web site (follow the link for "Information Resources"). They will also mail printed copies upon request. A sample of the titles available include:

- "Sunbook: A Guide to Solar Energy in North Carolina"
- "Passive Solar Options for North Carolina Homes"
- "Passive Solar Design Checklist"
- "Selecting a Site for Your Passive Solar Home"
- "Passive Cooling for Your North Carolina Home"

