Solar Residential Application

William Stoney
Deputy Director, Southern Solar Energy Center

Follow this and additional works at: https://commons.erau.edu/space-congress-proceedings

Scholarly Commons Citation
https://commons.erau.edu/space-congress-proceedings/proceedings-1981-18th/session-3/3

This Event is brought to you for free and open access by
the Conferences at Scholarly Commons. It has been
accepted for inclusion in The Space Congress®
Proceedings by an authorized administrator of Scholarly
Commons. For more information, please contact
commons@erau.edu.
ABSTRACT

The Southern Solar Energy Center (SSEC) is one of four regional solar energy centers funded by DOE as lead institutions for the commercialization of solar technologies. This paper describes their programs in general, and presents the progress and results of SSEC's Buildings Program in detail. Several residential designs which resulted from the program are illustrated and the energy saving features explained.

INTRODUCTION

The Southern Solar Energy Center (SSEC) is one of four regional solar energy centers funded by DOE as part of its solar commercialization program. The centers have been designated as lead institutions for the commercialization of solar technologies. Their mission is to promote in their respective regions, the rapid transition to inexhaustible and renewable energy sources.

The Southern Solar Energy Center began this task by assembling a staff of highly qualified professionals experienced in, and familiar with the unique characteristics of the southern region. Architects, engineers, economists, and market and information specialists are among those whose diverse skills and knowledge represent a singular resource for the region to draw upon.

SSEC programs are designed to be consistent with national planning, but are structured to meet regional needs. Concentration of effort is focused on identifying and commercializing those solar technologies which offer the most promise for the 19 jurisdictions which compose the southern region. Wherever possible, the existing regional and state resources are utilized to foster greater public awareness, acceptance, and use of solar energy.

The Center has developed programs which concentrate on those technologies which are commercially viable now and have the greatest potential for widespread application in the southern region.

They are solar water heating, passive/hybrid buildings, industrial process heat, wood combustion, windmills, and photovoltaics.

In each of these areas SSEC has developed projects and actions aimed at those parts of the region offering the best potential for that technology.

In this paper we will restrict our discussion to the SSEC programs directed toward the buildings market sector because we believe that the progress which has been made with these programs is significant and the results are very important in terms of their potential for mitigating the effects of energy inflation to the American homeowner.

THE BUILDING MARKET SECTOR AND ENERGY - WHY IS IT IMPORTANT?

While we are all becoming anxious about increasing utility charges for homes and buildings, few are aware that in total, these buildings consume over a third of our nation's energy while cars and transportation vehicles are only responsible for just a bit over one-quarter. Fewer still are aware that their electric water heater can use as many equivalent barrels of oil per year as the family car. (If your car consumes 550 gallons of gas in one year and you are a typical family of four using 80 gallons of electrically-heated hot water per day, you are using the equivalent of about 11 barrels of oil per year to satisfy each energy demand.)

Space heating, air conditioning, lighting and water heating make up the bulk of building energy uses. Solar technologies are presently available which can, with varying effectiveness, reduce the energy consumed. Solar technology is especially suitable for low temperature uses such as space and hot water heatings, thus, freeing oil and gas for use in high temperature applications where they are...
Because the building market is one of the largest energy users in the country and because the presently available solar technologies are well adapted to making considerable energy savings in buildings, the Building Program office has proposed that by the year 2000 the equivalent of as many as 2.2 million barrels of oil per day can be saved. Perhaps more important, it is projected that the integration of solar products and designs into the home can save the average homeowner 50% or more of his rising energy costs.

THE CHALLENGE - A YOUNG TECHNOLOGY AND A DIFFUSE INDUSTRY

Government programs in the past have generally supported advanced technologies which were of interest to large, well financed industries, i.e. Defense Aerospace, Communications, and Computers. The problem facing the building program is the integration of three consumer-oriented technologies into a market and industry made up of a very large (over 100,000) number of independent businesses. These entrepreneurs are typically small, highly competitive (small profit margin), technically conservative and sensitive to the marketplace demands. The three solar technologies (active, passive, and photovoltaics) which are in various stages of readiness for the marketplace will all require a certain amount of risk on the part of the builder, the retrofitter, the plumber, and the lender--in fact, by all of the elements in the industry who have to make their own individual decisions, before products will be made accessible to the general public.

Thus, while the potential for reducing oil imports, enabling the taxpayer to reduce his utility bills is large, there still remains the problem of rapidly diffusing the fundamental information from the solar R&D programs into all elements of the building market so that real economic and reliable consumer applications will result. This supporting action is essential even though tax incentives and rising fuel costs will also help stimulate a transition to solar energy.

The sheer number of industry decision makers who must be reached and the local nature of the building market, coupled with the direct relationship between the solar technologies and the local climate, calls for a decentralized program approach. Such an approach has already been initiated with the assignment of commercialization activities to the four regional centers. Each center in turn, has strong management and programmatic connections with industry and governmental elements in each of their states, providing the mechanisms needed to adjust program content to meet local needs. Also, technical staffs of sufficient depth and expertise are available to provide sound technical and market advice to the developing businesses.

THE PASSIVE PROGRAM

Passive solar technology is best thought of as a design technique rather than as a collection of specific products. Therefore, there is no passive solar industry equivalent to the active solar industry. The industry which must develop the product for the consumer is the building industry and this must be accomplished by individual builders integrating energy-saving passive techniques into the design and construction details of their houses. If programs are going to affect a significant change in the housing market, they must be able to reach a large percentage of the 100,000-plus builders which make up the bulk of the market.

As noted before, the residential building market is technically conservative and has a "show me" attitude toward new designs and/or construction practices. Therefore, one of the major methods of stimulating the home-building industry is to provide the technical assistance required to develop and build examples of practical energy-saving homes which will be marketable in the local building region. Because these designs must fit both the local climate and local tastes, and be applicable to a wide range of housing costs, the program which develops them must be scoped to reach a significant portion of the industry quickly.

The regional centers have already developed programs which have resulted in passive homes being constructed. The important feature of these programs is that they allow the individual builder to make the major style, size, and construction decisions and limit the government's role to supplying the solar technical expertise. These programs have resulted in the houses described in the following section.
ABOUT THE HOUSE

The Atlanta passive solar home is the product of a cooperative effort of the Southern Solar Energy Center, ARVIDA Corporation, builder Jim Brown, and Thompson, Hancock, Witte Architects. Significant support was also provided by a team of prominent local advisors.

The 2,929-square-foot home receives a significant portion of its heating needs from the sun, and this, combined with other energy-saving features reduces annual energy use to less than 45% of that for a typical new home in Atlanta. Primary design consideration was given to reducing winter energy demands through the use of passive solar heating. Special passive features include a sunspace, waterwall, and south-facing direct gain windows. Shading devices and insulation help reduce the summer air-conditioning loads. The house is bright, comfortable and in keeping with the prevailing style of homes in suburban Atlanta.

The chart at right shows this home's projected year-round energy savings.
SECOND FLOOR

PASSIVE ENERGY FEATURES
for heating and cooling

1. Water wall for solar heating and storage.
2. Two story sunspace for solar heating and heat distribution to both floors.
3. Wide overhangs for solar exposure control.
4. Special trellis for seasonal heating control of sunspace.
5. Masonry floors to store solar heat.
6. Solar air redistribution system to circulate heated air to interior from sunspace and waterwall.
7. Site orientation for proper solar exposure.
8. High insulation standards throughout.
10. Vestibule serves as an entry heat lock.
11. Room layout design with less occupied spaces grouped along northern exposure.
12. Garage location on northwest protects living spaces from cold winter winds.
13. Special landscaping (site integration and trees) provide winter wind break, and summer shade.
14. Wood frame, dual-glazed windows.
ABOUT THE HOUSE

The Houston passive solar home is the product of a cooperative effort of the Southern Solar Energy Center, Doyle Stuecky Homes, and the Houston-based architectural firm Environment Associates. Significant support was also provided by a team of prominent local advisors.

The 2,108-square-foot home receives a significant portion of its heating needs from the sun, and this, combined with other energy-saving features and special passive cooling techniques, reduces annual energy use to less than 50% of that for a typical new home. Primary design consideration was given to reducing the cooling energy use in order to meet the demands of the hot and humid climate. The house is bright, comfortable, and in keeping with the prevailing style of homes in suburban Houston.

The chart at right shows this home's projected year-round energy savings.
PASSIVE ENERGY FEATURES for heating and cooling

1. Passive direct solar heating in winter
2. Movable overhang shades first floor windows as needed
3. Special wide fixed overhangs control solar exposure on second floor
4. Masonry floors to store solar heat in winter, cool in summer
5. Brick interior walls store heating and cooling
6. Site orientation for proper solar exposure
7. Passive solar water pre-heater
8. Heat recirculating fireplace
9. High insulation standards throughout
10. Tight shell construction for infiltration control
11. Vestibule and laundry room serve as entry air locks
12. Windows with dual glazing and thermal breaks or wood frames
13. Reflective glazing on east wall
14. Window design for cross ventilation
15. High clerestory over kitchen/dining vents out excess heat
16. Garage location on northeast side protects living spaces from cold winter winds
17. "Vented" west wall with no windows rejects summer heat
18. Attic fan ventilation
19. Ridge and soffit attic venting
20. Radiant barrier in roof rejects summer heat

heat cool
" " X
X X
X X
X X
X X
X X
X X
X X
X X
X X
X X
X X
X X
X X
X X
X X
X X
X
Southern Solar Energy Center  Louisville House

SOUTH VIEW

ABOUT THE HOUSE

The Louisville passive solar home is the product of a cooperative effort between the Southern Solar Energy Center, Omikron Construction Company, and Chrisman, Miller, Wallace Architects. Significant support was also provided by the Homebuilders Association of Louisville and a team of prominent local advisors.

The 2328-square-foot home receives a major portion of its heating needs from the sun and this, combined with other energy-saving features, reduces annual energy use by approximately 50% over a typical new home. The home is bright, comfortable, and fits well with the prevailing style of homes in suburban Louisville.

A contemporary version of this house is also being developed to provide maximum aesthetic and marketing flexibility for the design.
PASSIVE ENERGY FEATURES
for heating and cooling

1. Trombe wall for solar heat collection, storage and distribution.  X
2. Sunspace for solar heating.  X
3. Two story solarium for heating and heat distribution to both floors.  X
4. Wide overhangs for solar exposure control.  X X
5. Trellis for seasonal heating control of trombe wall.  X X
6. Masonry floors to store solar heat.  X
7. Solar air redistribution system to circulate heated air to lower level.  X
8. Site orientation for proper solar exposure.  X X
9. High insulation standards throughout.  X X
10. Tight shell construction for infiltration control.  X X
11. Vestibule serves as an entry heat lock.  X X
12. Room layout design with non-habitable spaces grouped along northern exposure.  X
13. Garage location on northeast side protects living spaces from cold winter winds.  X
14. Special landscaping (earthberm and trees) on north side provide winter wind break.  X
15. Windows with dual glazing and wood frames.  X X
ABOUT THE HOUSE

The APOLLO model passive solar home is a product of Mayhill Homes Corporation, one of the largest manufacturers of panelized homes, and is the result of a cooperative design effort with Southern Solar Energy Center.

The 1,510-square-foot home receives a significant portion of its heating needs from the sun, and this combined with other energy-saving features reduces annual energy use to less than 45% of that for a typical home in Atlanta. Special design consideration was given to reducing winter energy demands through the use of passive solar heating; primarily by a south-facing solarium containing water drums, a thermal storage area which releases heat to the air as inside temperature goes down. Movable sun shades and insulation help reduce summer air conditioning loads. This passive solar system functions without mechanical components, by using the natural influences of the sun and environment to regulate the home's internal climate.

The chart at right shows this home's projected year-round energy savings.
PASSIVE ENERGY FEATURES for heating and cooling

1. Solarium for solar heat collection, storage, and control.
2. Movable shading for seasonal heating control of solarium.
3. Wide overhang for solar exposure control.
4. Solar air redistribution system to circulate heated air from storage to interior.
5. Site orientation for proper solar exposure.
6. Large amount of mass in sunspace to minimize temperature savings.
8. Tight shell construction to control infiltration.
10. Minimized east and west glazing to prevent overheating in summer and heat loss in winter.
11. Garage location on north protects living spaces from cold winter winds.

heat  cool

X  X
X  X
X  X
X  X
X  X
X  X
X  X
X  X
SOLAR WATER HEATING

In the Home. Anywhere from 20 to 30 percent of the average residential power bill is for hot water. Since utility bills now represent a sizable portion of the homebuyer's monthly expenses, reducing the cost of water heating can help stretch his housing budget.

Solar water-heating systems have been used successfully for years in several parts of the United States. More recently, builders and developers in states such as Florida, Arizona, California, Colorado, and New Mexico are offering solar hot water as an optional or standard feature in their new housing... and finding it to be a major selling point.

The builder who installs a solar system offers his buyer more than just energy savings, although those are considerable. As fuel costs rise and installed solar equipment costs remain constant, the purchaser enjoys ever-increasing dollar savings on his energy bills. In addition, federal tax credits for the installation of approved solar equipment can reduce the homeowner's income tax exemptions for solar equipment. Such credits when combined with monthly savings on utility costs can more than offset the larger down payments and slightly increased monthly payments for including solar system costs in the mortgage loan.

SSEC efforts in the area of solar hot water are built upon a goal to have 1.5 million solar water heaters in operation in the region by 1985. Education and promotion are the major tools used to encourage widespread acceptance of this proven technology. In Delaware, Florida, Maryland, and North Carolina, SSEC campaigns have applied traditional marketing techniques - radio, television, billboards, point-of-purchase displays, and direct mail--to inform the public of the benefits, costs, and operation of solar water heaters.

Studies have shown that when solar hot water is included in new housing as a standard feature it is readily accepted by the homebuyer. Consequently, major tract builders can play an important role in increasing the use of solar water heaters in the South. The marketing professionals at SSEC work closely with tract builders to educate them to the advantages and saleability of homes with solar hot water. In addition, SSEC conducts special promotional activities on behalf of large tract builders in the region who commit to include solar water heaters as standard features in their developments.

Light Commercial. Energy costs are rapidly becoming a major expense for many businesses--especially motels, commercial laundries, and other operations which use large quantities of hot water. Rising electricity rates have made solar water heaters economically attractive for these businesses, many of which can offset the cost of a solar system with their monthly utility bill savings.

In addition to energy savings, there are also tax incentives which reduce the overall cost of a commercial solar water-heating system. The Business Energy Investment Credit (IRS Form 3468) can be taken for 15 percent of a system's installed cost, and an additional 10 percent Standard Business Investment Credit applies if the solar system provides hot water for a commercial operation, such as an in-house laundry. Unlike deductions tax credits directly reduce the amount of tax owed. These tax incentives when combined with first-year utility bill savings can amount to 35 percent of the solar system cost.