1980

BUILDING AND SELLING THE SOLAR HOME

A PRIMER FOR HOMEBUILDERS

The Solar Business Office
State of California
Edmund G. Brown Jr.
Governor

ACKNOWLEDGEMENTS

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With special thanks to the many others who helped provide information, comment and criticism.

This primer for homebuilders was produced by the California Solar Business Office for the Solar Energy Research Institute, under Purchase Order No. AQ-9-3953-1. While we have made our best effort to validate the information used, neither the State of California nor the Solar Energy Research Institute makes any warranty, expressed or implied, nor assumes any legal liability or responsibility for the information contained herein.

JUNE 1980

INTRODUCTION

Solar energy is destined to play an increasingly important role in space conditioning and water heating in America. Solar design can help reduce the use of nonrenewable fuels for heating, cooling, and water heating. Residential energy use for these purposes accounts for 22 percent of total U.S. energy use. Forward-looking builders have already demonstrated the viability of a wide range of solar applications. Builders who become involved now will ensure that their homes will remain economical for their buyers to operate despite continuing energy price increases. At the same time, they will also gain experience with solar energy and may gain a market advantage as solar energy systems acquire an increasing share of the new home market.

California's builders have been in the forefront in using solar energy, not only for water heating but also for space heating and cooling. The California Building Industry Association, the California Solar Energy Industries Association, lending institutions and utilities have all recognized the financial and energy savings possible with good solar design and have developed a wide variety of programs to encourage builders to make their homes energy-efficient solar designs. They are succeeding, with tens of thousands of residences now served by solar installations and many thousands more under construction in 1980.

The developments in California's building industry are covered in detail as an example of one successful approach to promote building and selling solar homes. This report was prepared to help other state, regional, and local governments establish policies and programs for encouraging solar energy use by builders and developers. It also provides utility executives, lenders, builders, and developers with information on both building and selling the solar home and setting up programs to help builders get started in solar development.

SOLAR ENERGY IN CALIFORNIA

The nation's varied climates provide many opportunities for the use of solar systems for space heating and cooling and domestic water heating. This is fortunate because using solar energy is becoming very important — for the homeowner, the builder, the community, the utilities, and the nation. California includes more different climate zones than any other state, and the many successful solar developments illustrate clearly what solar can do — whether the demand is for space conditioning or water heating. Other areas of the country provide opportunities for solar energy applications, depending on their own unique combinations of available sunshine, heating/cooling needs, energy costs, and incentive programs.

California has one of the better developed solar markets in the United States. Solar energy systems served about 60,000 residences by the end of 1979 (estimated as 29,000 pool heaters, 21,000 water heaters, and 10,000 space conditioning systems). The California Building Industry Association and the California Solar Energy Industries Association have been in the forefront of educational efforts directed at builders. The State Energy Commission and the Solar Business Office have developed a number of programs to encourage uses of solar energy in new residential construction. Finally, developers and builders have been very active, with and without special incentives. For example, at the beginning of 1980, there were more than 120 subdivisions in California with solar water heating as a standard feature, as shown in the following map.

The builders and developers who have made the transition to using solar energy in new housing have always been pleased with the systems and with buyers' response to them. Recent polls show that most Americans finally believe that there is a shortage of energy and that solar energy can be an important source of supply in the near future. They have seen energy prices rise at more than twice the rate of inflation and are willing to look harder at the houses they will be buying, with an eye toward reducing their energy costs in the future.

The first step in every solar system design is the application of wise energy conservation measures. These include such things as: added insulation in walls, ceilings, under floors, and around pipes; special attention to weatherstripping, caulking, vapor barriers; choice of insulating windows and doors; selection of energy-efficient fixtures and applicances; and similar steps to reduce energy demand. These are even more cost-effective than solar systems and are the best energy investments anyone can make.

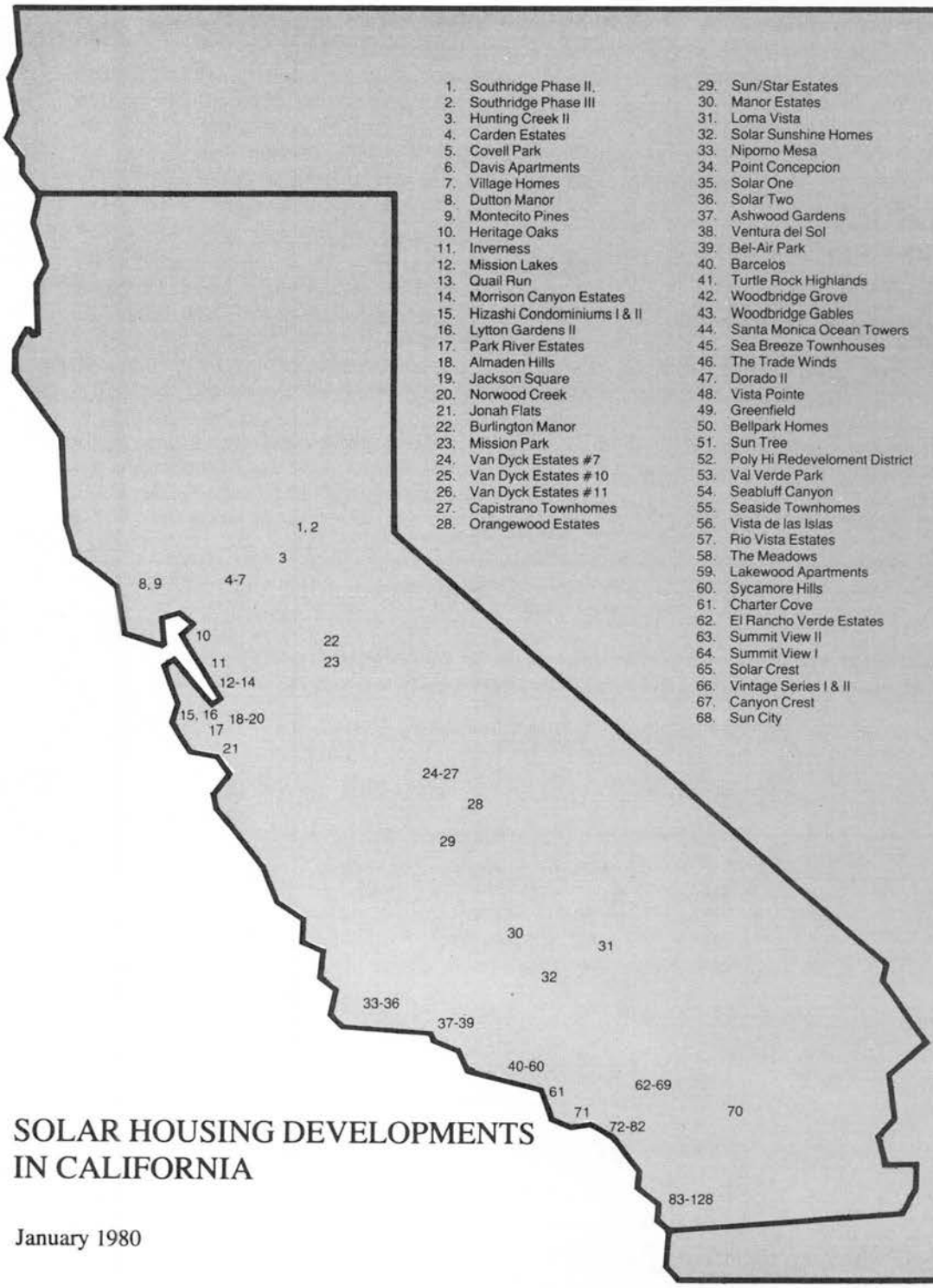
Residential energy use for heating, cooling and water heating accounted for 22 percent of national energy use in 1979. Therefore, the builder is in a key position to reduce America's dangerous dependence on non-renewable fuels. While doing this with solar systems and energy conserving design, the builder also can greatly reduce utility bills for the homebuyer and help the utilities by reducing the impact (particularly at peak periods) of new houses on the utilities' limited energy supplies. The widespread use of energy conservation features and solar systems in new construction also encourages retrofits of existing energy-wasting houses. It does this by training tradespeople in the necessary skills and by setting an example in the community.

Solar systems are a good investment, strictly on the basis of savings versus cost. Even without tax credits and subsidies, many types of solar systems are competitive with traditional energy sources. With the many tax credits and other financial incentives available today, a solar system may have a lower net first cost than traditional heating and cooling systems as well as much lower costs for operation.

Investing in solar systems also creates more jobs than investing in conventional fossil fuel or nuclear power plants. Studies suggest that a given investment in power production with solar energy will generate two to four times as many local jobs as the same investment in conventional energy systems. Even more significant is the fact that solar development will keep money in the community where houses are built, rather than sending it overseas for fuel or out of the area to a utility's stockholders.

Solar energy is also non-polluting. This makes it even more attractive for use in an ever more crowded world. No other energy source is as clean. No complex equipment is required to use this energy, and expensive pollution control devices are not necessary.

The many advantages of clean, economical, and reliable solar systems make ever more rapid growth in the market place inevitable. In 1976, there were dozens of solar systems installed in California, in 1977, there were hundreds, in 1979, there were tens of thousands, and in the 1980's, there will be hundreds of thousands of installations annually.



1. Southridge Phase II.
2. Southridge Phase III
3. Hunting Creek II
4. Carden Estates
5. Covell Park
6. Davis Apartments
7. Village Homes
8. Dutton Manor
9. Montecito Pines
10. Heritage Oaks
11. Inverness
12. Mission Lakes
13. Quail Run
14. Morrison Canyon Estates
15. Hizashi Condominiums I & II
16. Lytton Gardens II
17. Park River Estates
18. Almaden Hills
19. Jackson Square
20. Norwood Creek
21. Jonah Flats
22. Burlington Manor
23. Mission Park
24. Van Dyck Estates #7
25. Van Dyck Estates #10
26. Van Dyck Estates #11
27. Capistrano Townhomes
28. Orangewood Estates
29. Sun/Star Estates
30. Manor Estates
31. Loma Vista
32. Solar Sunshine Homes
33. Nipomo Mesa
34. Point Concepcion
35. Solar One
36. Solar Two
37. Ashwood Gardens
38. Ventura del Sol
39. Bel-Air Park
40. Barcelos
41. Turtle Rock Highlands
42. Woodbridge Grove
43. Woodbridge Gables
44. Santa Monica Ocean Towers
45. Sea Breeze Townhouses
46. The Trade Winds
47. Dorado II
48. Vista Pointe
49. Greenfield
50. Bellpark Homes
51. Sun Tree
52. Poly Hi Redevelopment District
53. Val Verde Park
54. Seabluff Canyon
55. Seaside Townhomes
56. Vista de las Islas
57. Rio Vista Estates
58. The Meadows
59. Lakewood Apartments
60. Sycamore Hills
61. Charter Cove
62. El Rancho Verde Estates
63. Summit View II
64. Summit View I
65. Solar Crest
66. Vintage Series I & II
67. Canyon Crest
68. Sun City
69. Blue Skies Radiant Homes
70. Sun Castles
71. Presidio Point
72. Discovery
73. Sunridge
74. Vida Pacifica, II
75. Apigan
76. Escondido Blvd.
77. Escondido Homes
78. Kaywood Forest
79. Maple Street
80. Northwood
81. Vermont Villas
82. Time for Living in Cardiff, Phase II
83. 3788 Grim Avenue
84. 3814 35th Street
85. 4015 Texas Street
86. 4062 Georgia Street
87. 4268 Winoa Street
88. 4768 35th Street
89. 4769 Hawley Way
90. 125 Arbor Drive
91. Alcer Condominiums
92. Casa Mayor/Sonata
93. Patterson Estates
94. Ponderosa Homes
95. Villa del Dios
96. Vista del Cielo
97. Kentfield
98. Friars Hollow
99. Loma Portal Villas
100. Valley Center
101. Oxnard Village
102. Navajo Park II
103. Windsong
104. Essex Project
105. Baranski
106. Winters
107. Meadowood/Sonata
108. Mirador #4
109. Time for Living in University City
110. Time for Living in Sonata, Phase III
111. Time for Living in Mira Mesa
112. Time for Living in Mira Mesa, Phase II
113. Time for Living in El Cajon
114. Time for Living in Santee
115. Time for Living in Santee, Phase II
116. Los Aboroles I
117. Los Aboroles II
118. Los Ranchitos
119. Davidson
120. Horowitz
121. Bonita Green/Blossom Hills
122. La Mesa Woods
123. Avocado Highlands
124. Parkway Villas
125. Vista del Colinas
126. Kimberly Woods
127. Ballantyne
128. Graves Avenue

SOLAR HOUSING DEVELOPMENTS IN CALIFORNIA

January 1980

HOW SOLAR SYSTEMS WORK

There are two basic types of solar systems, active systems and passive systems. Active systems have separate collection and storage components and require auxiliary energy for pumps and controls. Passive systems usually combine collection and storage and require no auxiliary energy to function. Each has advantages and disadvantages which must be considered for a particular application.

This chapter covers the basics of solar system design and operation. It includes five sections: energy conservation, solar water heating, space heating and cooling with active systems, space heating and cooling with hybrid systems (using both active and passive components), and space heating and cooling with passive systems.

ENERGY CONSERVATION

As a proper basis for solar system design, the builder should first apply all cost-effective energy conservation measures. These may be difficult and expensive to retrofit, but a builder can easily include them in new construction and thus acquire a reputation for comfortable, economical, and energy-efficient homes.

The most important steps for solar water heating are minimizing the length of hot water runs, properly insulating pipes and tanks, using flow restrictors, and choosing an energy-conserving water heater (possibly in conjunction with a heat pump, where electricity is used to heat the water).

More opportunities for saving energy are available for space-conditioning systems. The first step is good orientation, with a major wall and most windows facing south, with overhangs or other shading devices for summer sun protection. The second step is constructing a well insulated and weather-tight shell.

Exceeding the State Building Code (Title 24) insulation requirements is often desirable, using either 2" x 6" studs, 2" x 4" studs with insulated sheathing, or one of several other methods. Attics will also benefit from added insulation. Insulated doors and windows are advisable, and an airlock or vestibule entrance may be desirable as well. Interior insulated shutters for windows are very effective. The added cost for these measures will usually qualify for solar tax credits and utility financial incentives if a solar space conditioning system is constructed at the same time.

A well insulated house may suffer high infiltration losses in winter unless it is carefully weatherized with weatherstripping, caulking, and sealing. A polyethylene vapor barrier, sealed carefully around all openings such as electrical outlets, can reduce infiltration by more than fifty percent at a very reasonable cost. Well engineered and properly installed windows and doors will also improve the weather-tightness of a house. Foam-type caulks are effective around window and door frames; caulking under the door sill is also recommended.

For very hot areas, additional measures are warranted. These include use of a light-colored roof, provision of full shade for east and west windows (using shade-screen or exterior awnings), and window placement and interior design to maximize natural cooling with night ventilation.

SOLAR WATER HEATING SYSTEMS

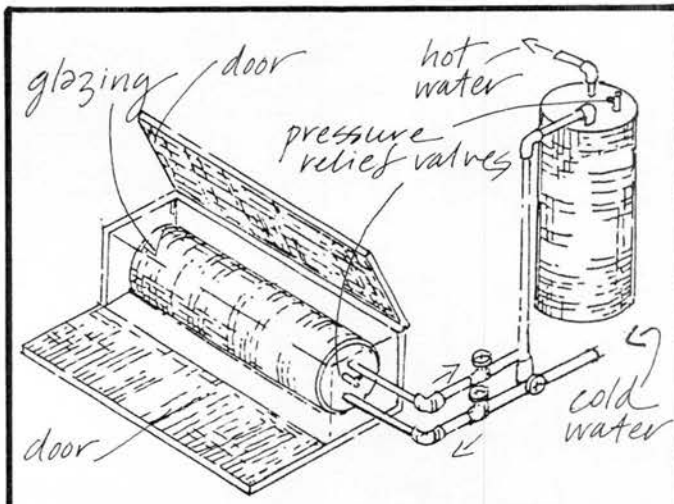
Solar water heating systems fall into one of the following categories: integral passive water heaters (which combine collection and storage), thermosiphon systems (which separate collection and storage, yet require no control or pump because they rely on natural circulation), and active systems (which require pumps and controls to carry collected solar energy to storage). Active systems can be either direct, using potable water, or indirect, with a working fluid used in a double-wall heat exchanger to transfer heat to the domestic water. Indirect systems may use either water with antifreeze, special heat-transfer fluids, or air to carry heat from the collector to storage.

The advantages and disadvantages of the different types of solar water heaters vary with the climate, site, esthetic considerations, structure and placement of backup water heater, availability of backup energy (gas, electricity, or propane), and the demand for hot water.

Important considerations include: development of an efficient system that actually conserves energy (in a poorly designed system, pumps and controls sometimes use up to 10 percent of the energy saved by solar heating) and development of a durable freeze-protection system that will work for many years without extensive maintenance or costly repairs. An effectively sized solar water heater (generally 45 to 60 sq. ft. of collector) will provide 65 to 85 percent of annual hot water needs, depending on location. A conventional water heater, or a solar storage tank with a built-in heating system is needed as a backup system.

Integral Passive Solar Water Heater

Integral passive solar water heaters are the least expensive systems, costing only about half as much as other systems. They are also reliable and easy to build. A typical integral passive solar water heater consists of 2 to 5 uninsulated water-heater tanks painted black and set in an insulated box, glazed on the south side. The system is used as a preheater: the supply water line runs to the passive solar water heater and then to the backup heater. The disadvantage of this system is the daily variation in water temperature; it is most effective when major hot water demand can be scheduled for late afternoon and evening. This oldest type of solar water heater was widely used in California and elsewhere in the 1890's and early 1900's. Integral passive solar water heaters are again becoming commercially available. They can also be assembled at the building site from components.

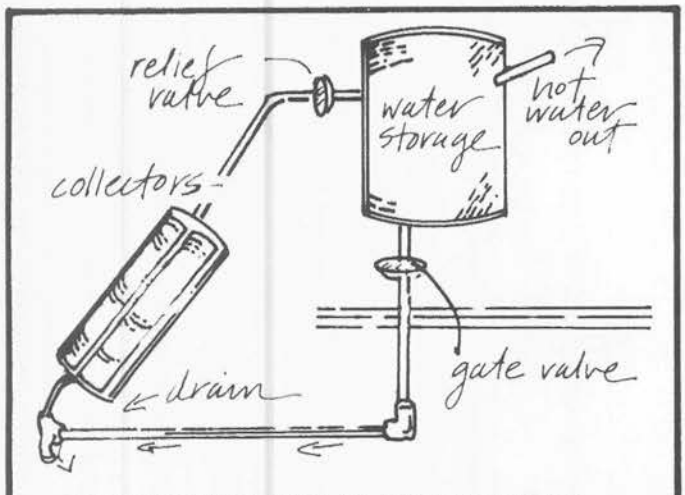


INTEGRAL PASSIVE SOLAR WATER HEATER

Thermosiphon Solar Water Heater

Thermosiphon solar water heaters are also passive solar water heaters. Because they do not require pumps or controls, they are very reliable. Unlike the integral passive solar water heater, however, a thermosiphon system separates the storage and collection functions. Thermosiphon systems more than 50 years old are still in operation, and tens of thousands have been installed in Australia, Japan, and Israel over the past thirty years. They are available from a number of manufacturers or can be site-built.

As the water in the solar collector is heated by the sun, it rises and is replaced by cooler, more dense water in the storage tank. This natural convective flow lasts as long as the collector is warmer than the storage tank. To prevent flow reversal at night, the water tank should be at least 12 to 18 inches above the top of the collector or must include a one-way flow control valve. The natural driving force in this type of system is not very strong so the water pipes should be large and not have many bends. The storage tank may include an electric backup heater.



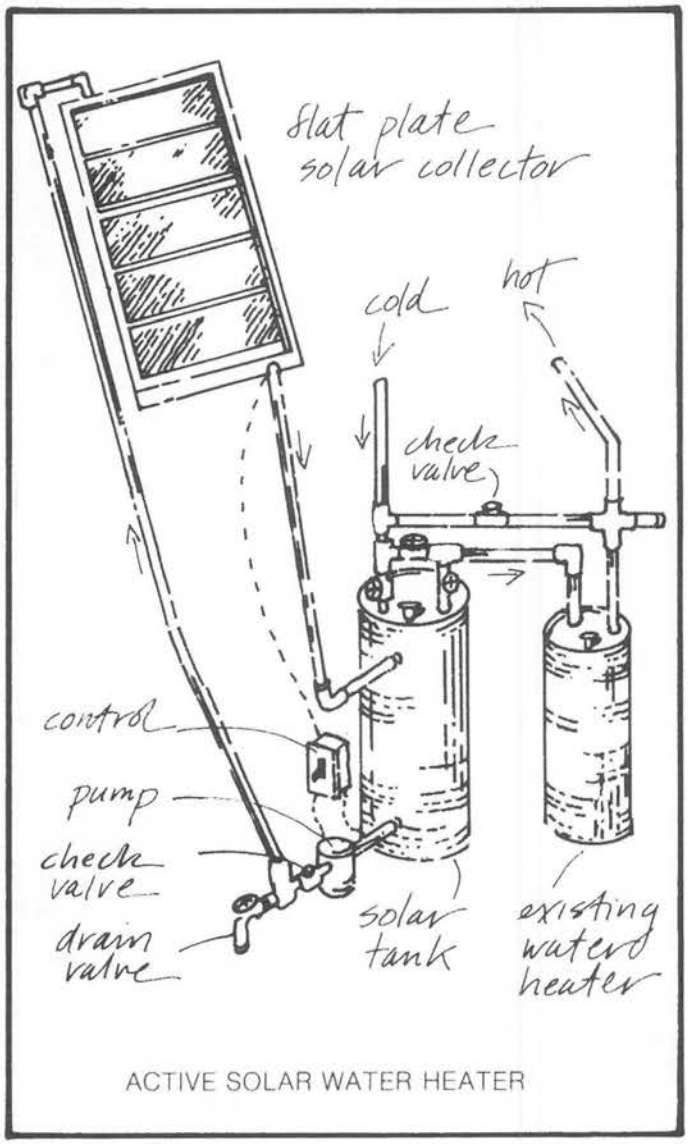
THERMOSIPHON SOLAR WATER HEATER

In areas where freezing is likely, a heat exchanger can be used with a freeze-proof fluid in the collector system. Either water with antifreeze, air, or special fluids may be used. Alternatively, thermostatically controlled valves in the lines can shut off the tank and drain the collector. Electric heat tapes have also been used to keep the collector and supply lines from freezing—but freezing temperatures often occur when the electric power is off.

Active Solar Water Heaters

The active solar water heater is by far the most common solar water heater in use today. It adds a pump and control system to the basic solar collector and storage tank, making it more complex and costly. However, active systems do have some advantages over the simpler designs, including more flexibility in collector and storage tank placement, and far greater availability from manufacturers. Active solar water heaters are also somewhat easier to protect from freezing because the controls and pumps are already included. The drain-down system is the least costly method for freeze protection and is satisfactory in milder climates. A control system can be installed that will drain the collector when there is a power failure. A back-up heater can be incorporated in the solar storage tank, or a two-tank system can be used.

In colder areas, the active system can use a non-freezing working fluid with a heat exchanger in the storage tank to heat domestic hot water. If air is used, then a single-wall heat exchanger may be used. If other fluids are used, a double-wall heat exchanger is often required by local building codes. The working fluid also helps extend the life of the collector system by reducing corrosion. However, the use of a working fluid and heat exchanger decreases the efficiency of the system, and a slight increase in collector area will be required to maintain a given level of performance.

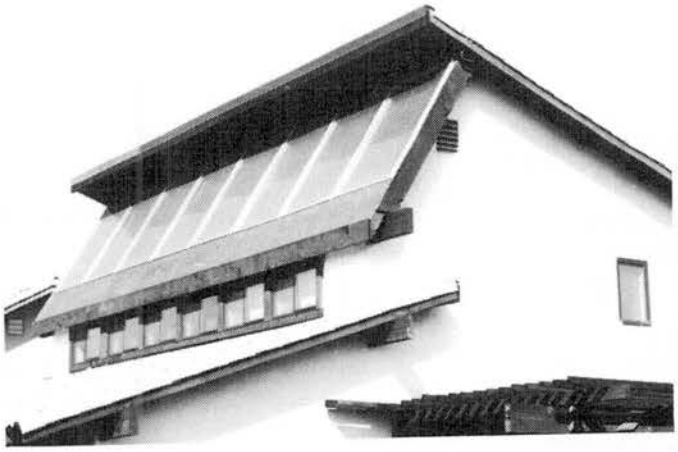


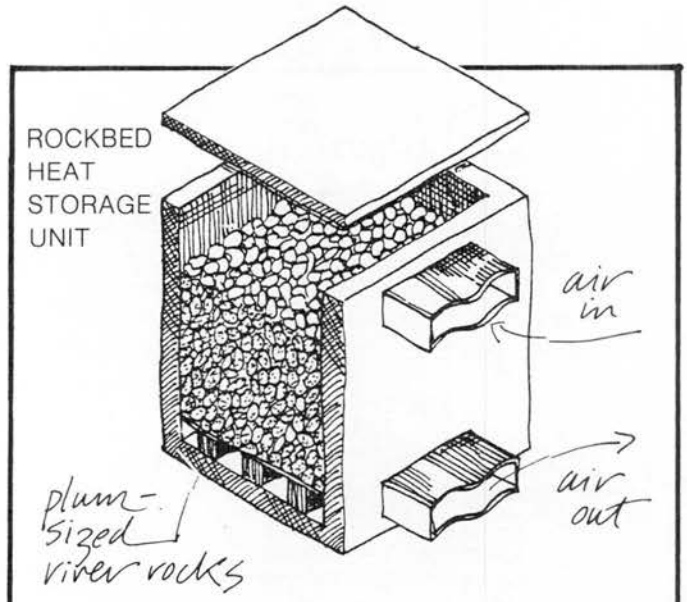
ACTIVE SOLAR WATER HEATER

ACTIVE SPACE CONDITIONING SYSTEMS

Two basic types of active systems, air and water, are used for space-conditioning. Space heating systems using water are similar to active domestic water heaters, and they are, in fact, often combined. Such systems include collectors, pumps, controls and a large tank to store solar heat for use on cloudy days. Heat is transferred to the living space by a heat exchanger fan, radiators, or radiant heating coils in the slab. A hydronic (water) system requires less storage volume than an air system, but requires more attention to leak prevention, as well as more complex controls. If the solar collectors are glazed with plastic rather than glass they can be used for cooling at night. An active hydronic system can be integrated with a heat pump to improve the performance of the heat pump.

Air systems use a different type of collector with much larger passages. From the collector, fans and blowers carry heat into a large rock bed for storage. Heat is drawn from the storage as needed. Disadvantages of this system include the fact that leaks may be undetectable, storage volume must be very large and the duct work for distribution can be bulky. Advantages are that air cannot freeze, a leak will not cause any damage, and the cost is usually lower than hydronic systems. Some air space heating systems take advantage of the building structure by using skylights and part of the attic as a heat collection area. An active air system can also be integrated with an air-to-air heat pump.





Cutaway view of unit. Hot air is blown through the rocks and heats them. Later, cool air is blown through and the warm rocks heat it for distribution to living areas.

ACTIVE SPACE CONDITIONING SYSTEM

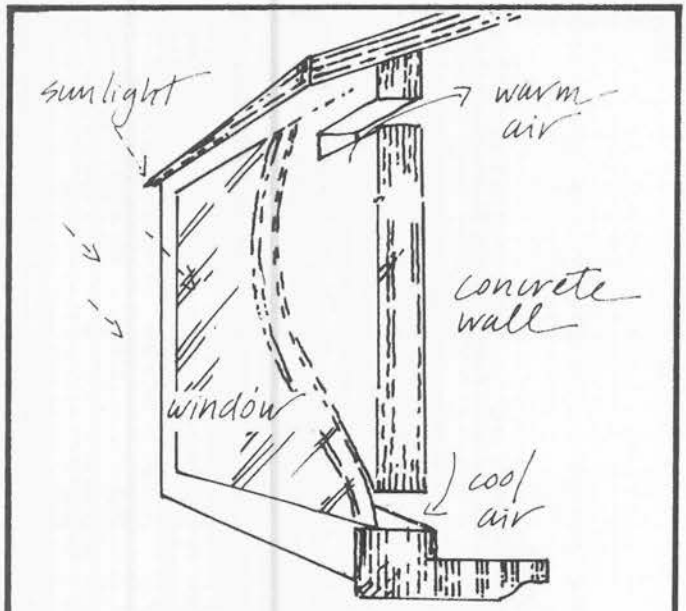
HYBRID SPACE CONDITIONING SYSTEMS

Passive and active systems can be combined to form "hybrid" systems. These are often very effective. One common hybrid system heats and cools the south side of the house with passive design features while the north side of the house receives supplemental radiant heating and cooling from coils in the slab that circulate heated or cooled water from an active system. Another attractive hybrid system begins with a simple passive home with south windows and thermal mass and adds an active air system for supplemental heating and added storage for cloudy periods.

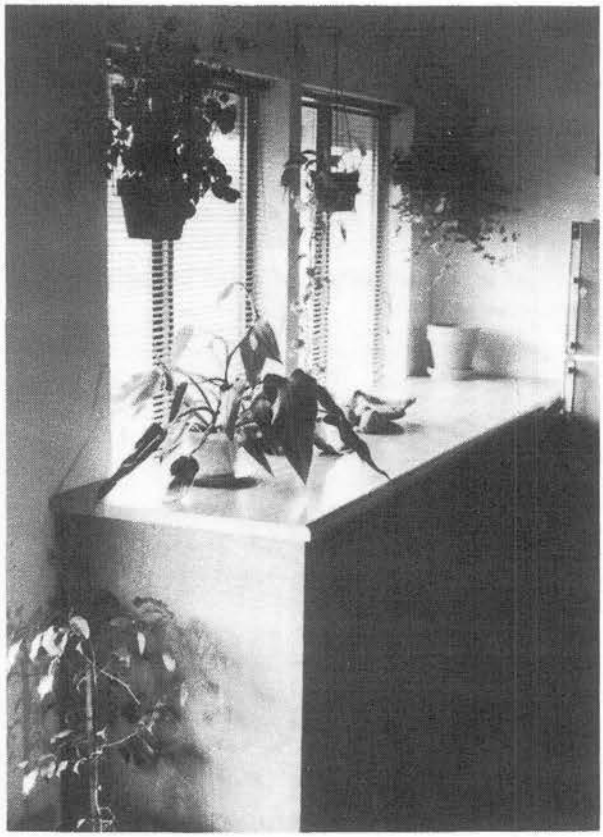
PASSIVE SPACE CONDITIONING SYSTEMS

The most effective and workable solar applications for space conditioning are passive solar systems. These can provide both heating and cooling using just solar energy and local climatic resources. The solar collectors for most passive systems are simply south-facing windows. Orienting a major wall to the south with considerable window area provides simple and effective solar heating. However, unless adequate heat storage and double-glazed windows are provided, the house may warm up excessively on a sunny afternoon and cool down too much at night.

Extreme temperature swings can be remedied by adding "thermal mass" to the house to store more solar energy, reduce over-heating during the day, and provide heating at night and during periods with no sun. Thermal mass includes such things as tile floors, water tanks, concrete slabs, rock walls, and the newer "phase-change" salts. For winter heating, thermal mass should receive direct sunlight a good part of the day. For summer cooling, thermal mass should remain shaded during the day.

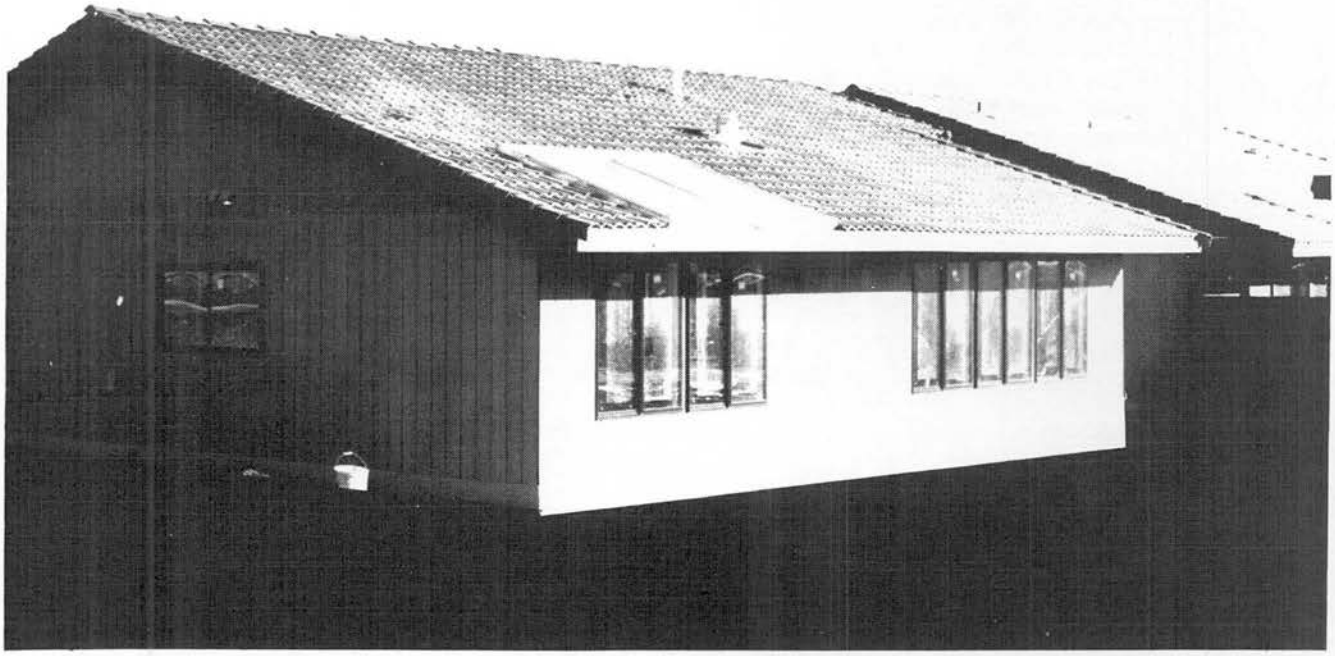


TROMBE WALL PASSIVE SYSTEM


A steel water tank provides thermal mass and functions as a utility countertop

Passive solar design can also reduce cooling needs by using local climatic resources effectively. The cooling load is reduced by minimizing solar exposure and solar gain in the summer with such things as overhangs, wing-walls, awnings, shadescreens, and light colors. Cooling can be provided by ventilating with cool night air using cross, stack and induced ventilation. More powerful cooling can be achieved by using the phenomena of night sky radiation and evaporation. Thermal mass can help store coolness for use during the hot days. Thermal mass used for cooling can be effective even if it is widely distributed through the house.

The simplest passive space conditioning system is a well insulated, weathertight house with most of the windows on the south side. With overhangs for shading, use of light colored roofs, and good cross-ventilation it can also provide much of the required cooling in many areas.



A simple passive solar home. Village Homes, Davis, CA.

It is possible to make a simple tract home an effective passive solar home by revising the building plans so that two-thirds of the windows face south and adding 50 pounds of water or 140 pounds of concrete (as thermal mass) per square foot of south-facing glass. A conventional tract home converted to a simple passive house would provide the following heating and cooling percentages in California's six major growth areas, according to a study done for the California Energy Commission:

GROWTH AREA	% HEATING*	% COOLING**
San Diego	90	60
Orange County	75	65
San Bernardino-Riverside	70	75
Los Angeles	65	90
San Jose	55	100
Sacramento	50	70

**To UBC (Title 24) Minimum of 72° F.*
***To 78° F.*

By adding more glass (40 sq. ft.), more thermal mass (as above, to suit added window area), and insulated shutters to this house, the study showed even better performance could be achieved:

GROWTH AREA	% HEATING	% COOLING**
San Diego	100	85
Orange County	95	90
San Bernardino-Riverside	95	95
Los Angeles	90	100
San Jose	75	100
Sacramento	65	100

**To UBC (Title 24) Minimum of 72° F.*
***To 78° F.*

SOLAR ACCESS

Solar homes will not work well unless they receive enough sunlight. Provision of sufficient solar energy on the solar collection surfaces requires solar access planning. This was not necessary when the first solar homes were built out in the country on twenty acre lots, but now that they are being built in large subdivisions, with 5 to 8 units per acre, solar access planning is essential.

The increased use of solar energy has many legal ramifications. At this time, "solar rights" do not exist in much of the country, although several bills now proposed would establish this right. California's Solar Rights Act (Chapter 1154, 1978) encourages solar access planning, but does not mandate it. Fortunately, however, fairly good protection of solar access can be accomplished using good design methods, primarily involving lot layout and building placement practices.

One of the best ways to protect solar access is with a simple provision in a subdivision's convenants, conditions and restrictions. An example from Village Homes in Davis, California, is included.

STREET ORIENTATION

In most areas, street orientation is the most important concern for the builder/developer. Street orientation usually determines house orientation with the houses facing the street, and major yards to the front and back. In most areas, orienting the streets predominantly east-west, with minor bends, is desirable for improving solar-heating performance. This orientation allows most houses to be built as simple passive solar systems with lowered heating and cooling bills. If streets run north-south, solar systems can still be employed but active solar systems using roof collectors rather than the less expensive and more reliable passive solar systems, using south-facing windows, may be required.

SETBACKS

More flexible setbacks can provide good solar access even where street orientation or vegetation is not favorable for solar utilization. "Zero" lot-line setbacks are particularly useful for ensuring solar access. They have been used for other purposes for many years with few problems.

Fence location may discourage use of wise passive solar design. For a house with a south-facing front yard, the front fence may keep most of the winter sun from windows unless the fence is moved closer to the street or is lowered in height.

LANDSCAPING

The developer/builder also influences landscaping to a great extent; this is important for continued solar access. Trees can provide much needed summer shading without blocking collectors or window areas if they are chosen and planted carefully. Summer shading for houses is particularly desirable with east and west exposures, not so much on the south as might be expected. If trees are planted in the right location, they can provide good shade in summer and allow full solar exposure in winter.

Trees and shrubs can also improve ventilation if properly placed. This can be very helpful for cooling houses in areas with cool night breezes. Trees and shrubs can act somewhat like a dam in a river and direct cooling breezes through windows for summer cooling. In addition, evapotranspiration of large amounts of water from trees and shrubs can cool the area around a house as much as 10° to 20°F, thereby reducing air conditioning loads by 20 to 50 percent.

SOLAR RIGHTS

Now, therefore, the lot owners, and the declarant, Village Homes, do hereby modify said Declaration of Covenants, Conditions and Restrictions as follows:

All south-facing glass and solar space heating collectors in each house shall remain unshaded from December 21 to February 21 between the hours of 10 a.m. and 2 p.m. (solar time), except as provided herein.

All roof-top solar hot water collectors on each house shall remain unshaded each day of the year between the hours of 10 a.m. and 2 p.m. (solar time), except as provided herein.

Shading caused by the branches of deciduous trees shall be exempt from this restriction.

Shading caused by original house construction, or fences built within six (6) months of occupancy shall be exempted from this restriction only upon special approval of the Village Homes Design Review Board.

Homeowners may encroach upon their own solar rights.

The Board of Directors of the Village Homeowners' Association shall have the authority to enforce this restriction.

PROGRAMS FOR PROMOTING SOLAR HOME BUILDING

A variety of programs have been developed to promote a more rapid transition to widespread use of solar systems. Summarized here are financial incentives, educational and technical assistance efforts, and regulatory programs. Programs that are specifically aimed at marketing solar homes are discussed below in "Building the Solar Home."

FINANCIAL INCENTIVES

Solar Tax Credits

The California state tax credit permits the builder or owner of a home using qualified solar systems to receive a 55 percent tax credit . This means that 55 percent of the cost of the solar system and related conservation measures can be subtracted from any state income tax liability. The credit can be carried forward until it is used up. The owner or developer can pass the tax credit on to an original buyer or else keep it.

The National Energy Act of 1978, as amended, provides a solar tax credit for 40 percent of the first $10,000 of expenditures. Eligible systems are more restricted than for the state solar tax credit. The federal law allows a separate conservation credit of 15 percent of the energy conservation expenditures added to homes built prior to April 20, 1977.

Federal and state tax credits can be combined to approach the full cost of installing the solar system, in some cases. The maximum credit can usually be obtained if the builder claims the state credit, and the buyer claims the federal credit, particularly for solar water heating systems. Detailed information on the regulations for the state and federal solar tax credits can be obtained from the California Energy Commission and the Internal Revenue Service, respectively.

Priority Processing

The California Department of Real Estate established a policy of giving priority consideration in processing the Public Report (needed before a sale can be closed) to builders who use solar systems. This incentive exists by administrative policy rather than statutory authority. It can sometimes save a builder 2 to 4 months in processing time. Some city and county planning and building departments also have taken similar action in this direction. Where priority processing in used, the builder stands to gain substantially from the earlier sale of a solar home.

Loan Processing

Some lending institutions provide incentives for the use of energy conservation measures and solar energy systems. These incentives include reduced interest rates, extended loan terms, higher loan-to-value ratios, and the issuance of larger loans than would otherwise be possible for specific buyers (since a reduced utility cost can contribute to an increase in usable family income, from which increased payments can be made).

Disaster Area Solar Loans

The California Department of Housing and Community Development can provide interest-free loans up to $2,000 for installation of residential solar space-conditioning or water-heating systems in repaired or rebuilt houses in disaster areas declared by the Governor between July 1977 and December 1980. Loans must be repaid within three years.

Line Extension

The California Public Utilities Commission (PUC) has eliminated present free line extension to builders by investor-owned utilities. In 1980, the utilities will offer cash awards as "conservation allowances" only to builders with significant conservation or solar features in their homes. In addition, line extension allowances will be granted only to builders with specified energy conservation and solar features. Final details of the PUC program are expected by July, 1980.

Utility Incentives

Utilities have also begun to offer a variety of incentives, including direct rebate, low-interest loans, and other financial incentives. Pacific Gas and Electric's Suntherm program for passive systems in new homes, offering direct rebates of up to $1,000, is probably the most important at this time.

To qualify for PG&E's Suntherm Home Program each dwelling must qualify as a Premium Energy Conservation Home (PECH). These homes feature a wide variety of conservation devices and systems and use about 25 percent less energy than similar homes built to meet minimum local, state,and federal standards.

A Suntherm Home must also use solar design features that provide from 50 to 75 percent of the PECH's remaining energy needs for space and water heating, and the builder must give PG&E the option of monitoring each home for at least five years.

It is estimated that the Suntherm Home will cost about $5,000 more to build than a comparable conventional home, but many will, in addition to the PG&E incentive payment, qualify for substantial state and federal income tax credits and eliminate the need for a central heating and air conditioning system. Suntherm Homes will have lower energy bills and help hold down utility rates for all PG&E customers by reducing future needs for high-cost fossil fuels or new electric power plants.

Utilities have also developed a variety of recognition programs for builders of energy-efficient homes. In 1980, they will distribute State-approved lists of solar contractors as part of the national Residential Conservation Service program.

Secondary Mortgage Market

The various federally established programs involving the secondary mortgage market either have developed or are developing plans that will encourage or facilitate solar installations. Agencies include the Federal National Mortgage Association, the Federal Home Loan Mortgage Corporation, and the Government National Mortgage Association. In addition, FHA, VA, and Farmers' Home Administration, as well as the state's "Cal-Vet" program, are authorized to increase loan ceilings by up to 20 percent for homes with solar energy systems.

Solar panel installation on a solar home in Ukiah, California. A P G &E Demonstration Project.

There has been no overt discrimination against solar energy systems by the secondary mortgage market, and systems are generally being appraised at "value = cost" in the absence of significant resale information. However, people who buy solar-assisted homes with their own funds are penalized by having to pay 20 to 25 percent of the solar system cost in the down payment and by having to make additional monthly payments of $20 to 50. This inequity can be remedied by lenders through including energy cost in the underwriting standards for calculating monthly housing payment cost and by lending on 100 percent of the solar system cost (in effect creating a slightly higher loan-to-value ratio).

LENDERS' PERSPECTIVES

Solar building has been financed with HUD, FHA, VA, Farmers' Home, Cal-Vet, and normal loan procedures. Several banks have made an effort to encourage solar by reducing loan rates ¼ percent to 1 percent and offering incentives, such as including reduced energy costs in the calculation of the monthly qualifying income.

A Solar Business Office survey in 1979 of lending institutions in California found that loans are regularly being made for a wide range of solar projects, from solar subdivisions to retrofits, apartments to commercial buildings, and single-family residences to condominiums. The major concerns of the lenders focused on the reliability and life expectancy of the systems. Others mentioned the cost-effectiveness of the system and maintenance cost as another area of interest. If the builder has chosen the solar system wisely and prepared the necessary background information, there should be no delay in loan processing.

EDUCATIONAL AND TECHNICAL ASSISTANCE

Several programs have also been developed to provide educational and technical assistance for builders. Foremost among these are the efforts of the California Energy Commission (CEC), Solar Business Office, SolarCal Council, California Building Industry Association (CBIA), California Solar Energy Industries

Association (CAL-SEIA), utilities, and several local governments.

California Energy Commission

The California Energy Commission has developed a variety of programs to assist builders in solar development. Principal among these are descriptive information and pamphlets such as "Solar Systems for Residential Hot Water," "The Solar Tax Credit," and "Planning for Solar Access." An extremely useful and well prepared manual on passive solar design will be available in 1980. It features construction details, performance data, and other information not readily available to the builder.

In addition, the Commission has supported the educational efforts of the CBIA and CAL-SEIA including preparation of the "Solar Energy Handbook for Builders," "The Solar Tax Credit Notebook" and workshop series, a local government workshop series with the League of California Cities, and many other programs. The Solar Office of the Energy Commission has also reviewed building plans and subdivision designs for builders to point out the solar improvements possible with minor and inexpensive revisions.

Solar Business Office

As one of the solar industry's major links with state government, the Solar Business Office acts as ombudsman for industry and an ear for the government. It advises state government agencies on new laws and regulations affecting the solar industry. It keeps the state government informed of the industry's needs, especially in helping business-oriented departments in housing, real estate and finance, to shape policy and programs to promote business assistance and market development for the solar industry. In support of these efforts the office has held a number of seminars for builders, lenders, and real estate licensees to familiarize them with solar and to bring their concerns to the attention of the state government. In addition, the office had developed a series of reports on various solar topics of particular value for builders and solar businesses: these include this report, the "California Solar Business Directory," and a report on consumer loans for solar systems.

SolarCal Council

The state SolarCal Council also provides assistance for solar development. This advisory and advocacy body of business, labor, and citizens' groups is responsible for developing plans and programs to meet the state's goal of 1.5 million solar homes by 1985. The initial plan, "Toward A Solar California: The SolarCal Council Action Program," released in 1979, now provides a basis for state solar commercialization efforts. The Council also operates a toll-free "hotline" to answer consumer inquiries about solar energy.

California Building Industry Association

The CBIA has conducted a series of well received seminars on solar energy for builders in conjunction with the CEC. One of their most effective programs was a series of seminars on "Solar for Builders," attended by more than 3,000 builders and contractors in 1978-79.

California Solar Energy Industries Association

In conjunction with the California Energy Commission, CAL-SEIA began a series of seminars on solar tax credits in 1979. The series will continue in 1980. In addition CAL-SEIA has an inspection program and a warranty program. These are described later.

Utilities

The utilities have also been involved in a number of educational and technical assistance programs. The Sacramento Municipal Utility District (SMUD) for example, sponsored a seminar on "Neighborhood Design for Energy Conservation" to help reduce the energy impact of new subdivisions. Pacific Gas and Electric Company sponsored a similar program on passive solar design.

Southern California Edison Company (SCE) offers a five-year service agreement to homeowners at a cost of $200 wherein they maintain solar water heaters for the last 4 years of the agreement, and the installer maintains it the first year. Heaters must have electric backup. The conditions of the agreement are: 1) The solar system must be eligible for the tax credit; 2) Its design must be approved by SCE; and, 3) The installations must be inspected by SCE. This program has existed for the past two years.

San Diego Gas and Electric Company has been very active in promoting solar installations in its service area. Among its activities are advertising the availability of the state solar tax credit on radio and in local newspapers and co-sponsoring tax credit seminars. They are also conducting two monitoring projects, one in Rancho Bernardo (domestic hot water with natural gas backup on 12 homes) and the other in cooperation with the County of San Diego involving 50 to 90 water heating installations.

The Sacramento Municipal Utility District (SMUD) will begin a new assistance program for builders, aimed at encouraging the use of passive solar in tract housing. A computer model will analyze energy use and the SMUD staff will suggest design modifications to improve performance. The program is for outreach directly to major contractors.

REGULATORY PROGRAMS

Many programs have been developed to regulate or mandate various aspects of solar design. Foremost among these are the California Energy Commission's Testing and Inspection Program for Solar Equipment and the solar tax credit regulations. Activities of the California Departments of Consumer Affairs and Housing and Community Development, the California Building Officials Organization and various local government programs, particularly those in Davis, San Diego, and Cerritos, are also mentioned because of their impact.

California Energy Commission

The most important program of the commission in this regard is its "Testing and Inspection Program for Solar Equipment" (TIPSE). The goals of TIPSE are to provide reliable, comparative information about certain solar equipment. Tests measure performance, reliability, and durability. Certification of solar collectors provides accurate information including:

- A description of the product and the results of the tests performed by a laboratory accredited by the Energy Commission. Consumers then are able to compare one collector with another.
- Installation information which describes installation, storage and handling requirements.
- Application information which consists of operation, maintenance, warranty, and repair information.
- Information about manufacturing procedures to ensure that each piece of equipment available to consumers is equal in quality to the tested component.

The current voluntary program issued its first set of certification labels in April 1979 for flat-plate glazed collectors. Builders will be able to judge better the quality and performance of collector panels as a result of this program. TIPSE will be extended to other components in time. As of January 1980, 100 models of collectors from 46 manufacturers had been certified under TIPSE.

The Energy Commission is responsible for providing information related to required warranties for solar systems. There are currently no warranty requirements for passive solar. For active solar systems, several different warranties may be required for eligibility for the state tax credit. Solar systems, as such, do not require a warranty to be sold in California, but there must be a 3-year full parts and labor warranty on all collectors, storage tanks, and heat exchangers, and a 1-year full warranty on the installation to qualify the system for the state solar tax credit.

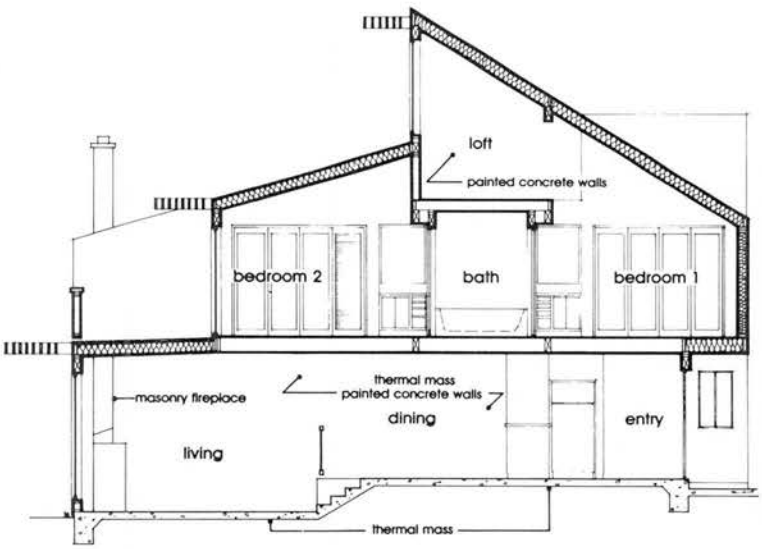
Department of Consumer Affairs

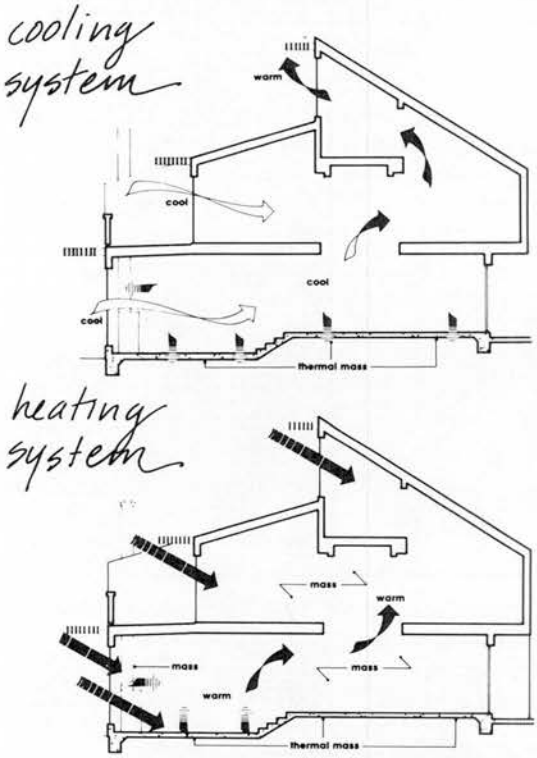
The Contractors State License Board, a division of Consumer Affairs, now requires contractors who install solar systems to obtain a supplemental solar license, SC-44. This may be attached to any of the seven license classifications now allowed to perform specific solar installations. The solar contractor must report semi-annually on solar systems installed.

Department of Housing and Community Development

The state building code is a major factor in building. It is being revised to encourage solar development as well as energy conservation. The energy regulations are extensive and greatly influence commercial as well as residential building. The Department also acts as a mediator in disputes involving builders and local building officials.

Sectional view, winner 1979 California Passive Solar Design Competition, Multi-Family Design Category. Architect/Designer: David Mogavero & Associates, Sacramento, CA.





California Building Officials Organization (CALBO)

In conjunction with the Energy Commission, CALBO has developed a manual to help interpret the State Building Code on questions of solar design. In 1980, CALBO will conduct a series of seminars for builders and building officials on the manual.

Local Programs

The City of Davis has set an example of local government action on solar matters. In 1976 (after two years of development), the City Council adopted an Energy Conservation Building Code. In essence, this code requires passive solar design for all residential units built in Davis. It was supported by planning policy to ensure good solar access. Initial builder resistance to the Code changed to support after the effectiveness of the program became apparent (fifty percent energy savings were typical). In 1979, the City passed a retrofit ordinance requiring home energy performance improvement on all resales. Addition of a solar water heater or passive features are among the more likely improvements to meet the ordinance requirements.

San Diego County took a different step in 1979, mandating solar water heaters on all residences in areas not serviced by gas. As shown in the following section, this use makes good economic sense. It went into effect as of October 1979. Santa Barbara County has also mandated solar water heaters for new residences in all-electric areas. And the cities of Cerritos and San Dimas have passed ordinances requiring fifty percent of all subdivision units to have solar systems. This allows for flexibility in placement and has been well received. Other cities considering mandatory solar ordinances in 1980 for solar water heating include Davis, Santa Barbara, Sacramento, and Los Angeles.

THE ECONOMICS OF SOLAR SYSTEMS IN CALIFORNIA

The economics of solar systems vary with climate, site, design, and the applicability of the various financial incentives mentioned previously. California's 55 percent solar tax credit and the federal tax credits for renewable resources are particularly important and make many solar systems economically attractive.

PASSIVE SPACE CONDITIONING

Passive space-conditioning systems are generally more cost-effective for several reasons. They use building components such as double-glazed windows that would be purchased in any case. These often can be claimed for the solar tax credit. Passive space-conditioning systems also make additional energy-conservation elements eligible for the tax credit. The combination of energy-conservation measures and passive design will reduce (and in some cases eliminate) the need for back-up cooling and/or heating.

Example, Passive Space Conditioning System, Davis, California:

COMPONENT	COST (1979)
South glass (eligible cost)	$ 500
2"×6" walls (vs. 2"×4")	250
Added insulation	300
Casablanca fan	110
Added overhang	220
Extra weatherstripping	180
Water tank mass	500
Thermal drapes	400
TOTAL	$2,460 (Labor included)

This system may look expensive, but because the system provides full cooling, no central air conditioner is needed. This saves $1000 to $2500. The system also provides enough of the heating that a small wall heater can be used in place of a central unit. This saves another $300. Thus, the net system cost ranges from nothing to $1,160. Now, consider the tax credit. For qualifying systems, California allows a credit of 55 percent of the cost on all items listed. This amounts to $1,353. Subtracting this from the net system cost results in the system actually saving at least $193 as an initial investment!

In addition, the system will save 100 percent of the air-conditioning costs of a standard house and 80 percent of the heating cost. Compared to a conventional house, with recent energy price increases, this amounts to more than $400 per year. If the real cost of utilities quadruples over the next 30 years, the passive system will save about $24,000 over the lifetime of the house, for no net initial cost!

ACTIVE SPACE CONDITIONING

For an active system the savings are not as dramatic but are still significant.

Example, Active Space Conditioning System, Los Angeles, California:

COMPONENT	COST (1979)
Collectors (200 sq. ft.)	$2,600
Controls	300
Pumps	200
Storage	1,200
Pipe and distribution	400
TOTAL	$4,700 (Labor included)

This type of system generally provides heating only, so an air conditioner will still be required. However, the heater can be downsized for a saving of $200. Again, all components are eligible for the 55 percent tax credit, as are associated conservation measures totaling $300. With state and federal tax credits totaling $2,750, the net investment is only $1,750.*

For a net investment of $1,750, an annual utility savings of about $165 vs. gas and $330 vs. electricity (early 1980 prices) will be realized. Assuming energy prices rise only 4 percent a year above inflation, loan cost is 15 percent and the inflation rate is 10 percent, the system's net yearly cost, amortized over 15 years, is $129.** This system is more likely to need maintenance and repair. A visit every two years and replacement of pumps might cost $500 over the life of the system. Thus the real cost is about $165 a year, with a yearly saving of $165 against electricity and a breakeven against gas. This estimate is very conservative. Although fuel price increases have been averaging 15 percent per year above inflation since 1974, there was a 35 percent jump

in 1979. Also, this analysis does not assess the costs of solar energy against the cost of new gas or electric supplies, which are nearly double the current average cost of energy paid by the consumer.

INTEGRAL PASSIVE SOLAR WATER-HEATING SYSTEM

Example, Integral Passive Solar Water Heater, San Bernardino, California

With passive water heating, the savings can be considerable. In this case, the total system cost is $1,200. State and federal tax credits total $660, leaving the net system cost at $540.* The annual cost of this system, assuming the same interest, inflation and energy prices as for the active system, would be $40. This system will provide about 50 percent of the hot water for the year. For a typical family, the saving on utility bills will be about $60 for gas backup and $100 for electric backup. Therefore, the annual net benefit would be about $20 against gas and $60 against electricity. Note that a thermosiphon system would provide about 80 percent of the net savings of the passive system, assuming that the former cost $1,800 installed and provided 20 percent more annual energy.

ACTIVE SOLAR WATER-HEATING SYSTEM

Example, Active Solar Water Heater, Orange County, California

Active solar water heaters can also be an attractive investment. For a total system cost of $2,000, with state and federal solar tax credits totaling $1,100, the net system cost would be $900.** The annual cost using the above assumptions of energy price increase, loan rate, and inflation would be about $67. For a typical family, this system would save about $80 per year in gas costs and about $130 per year in electric costs. Thus, the system is marginally cost competitive with gas and an excellent alternative to electric water heating. If the builder uses the tax credits effectively and further reduces the cost of the solar system, then the system is even more economical.

An active water heating system under construction, before glazing.

**Does not include additional credits available in new housing to builder/buyer if the builder takes the state solar tax credit, the buyer takes the federal solar tax credit, and the state credit is taken for associated energy conservation measures. The cash value of this credit can often exceed 80 percent of the solar system's installed cost.*

***The annual real cost of the system in this case is therefore: Loan 15 percent minus net energy price increase 11 percent, equaling 4 percent. Annualized cost per $100 over 15 years is $7.40. This calculation does not include property taxes (1 percent) or the tax deduction for interest paid, about 3 percent to 4 percent of the loan cost.*

BUILDING THE SOLAR HOME

"The next time you see a house being built 'the-way-we've-always-done-it,' you'll be watching a multi-thousand dollar product go obsolete before it's even finished."—Better Homes and Gardens

The first step in building a solar home is determining what type of solar system to use. This may be done in-house by the builder's design staff or architect or with the assistance of a professional solar consultant, architect or engineer experienced in both passive and active solar system design.

In most cases the existing stock plan can be revised to be more energy efficient and incorporate passive solar features. This will generally involve improving insulation and weatherproofing, adding more south windows with double glazing, and incorporating more mass in the structure; for example, a tile-on-slab floor in the dining room and entry, a water tank in front of south glass, a masonry wall, or any of the other types of thermal mass now being used. It may also include minor changes to improve cross-ventilation for natural cooling. A whole-house fan, attic fan, or Casablanca fan may also be added. In most cases the existing plan will not have to be extensively revised.

After these improvements are made at the design stage, it is helpful to prepare a computer simulation of house performance over a year. This can be done by a solar consultant or by a firm specializing in this service. In most areas in California, a simple passive solar house of this type will achieve better than 50 percent heating and cooling. These improvement costs, including consulting and simulation work, are eligible for the 55 percent tax credit in California, as are the costs of securing solar access and easements or other deed restrictions.

After this essential first step, the builder should investigate the opportunities for even better performance; for example, the development of a series of more refined passive systems, such as an optional solarium or solar chimney (for added ventilation), and the addition of active solar systems to augment the performance of the passive space-conditioning system or to provide the domestic hot water. After the more likely combinations of systems are developed, they should again be tested by computer simulation. The best combinations should then be carefully detailed with cost estimates. In the case of solar water heaters, the builder may wish to short-circuit these steps by simply contracting with the regular plumbing or sheet metal subcontractor or with a qualified and experienced solar company for the job.

At this time, an application to the "CAL-SEAL" program or a visit with a qualified consulting firm is advisable to determine the most cost-effective system for using the federal and state solar tax credits. The consultant will also be able to describe the warranties and specifications required for the system to qualify for the tax credit. The interaction between these is complex but worth careful investigation because in many cases the combined tax credits for the builder and buyer in California may approach the total cost of the system.

SOLAR BUILDING IN PRACTICE

At this point, it will be helpful to explore some of the more attractive combinations of solar systems now being used. Examples are included from the single-family detached house market, the apartment and condominium market, and the custom home market. Several major developments now in the initial building stages will feature solar systems. One of the larger projects is Rancho San Clemente, a 2,700 unit development in Orange County using passive solar space conditioning and solar water heating as standard features.

SINGLE-FAMILY DETACHED

SunRidge, Sacramento, by Paintridge Design and Development of Davis

"We had originally planned to build 20 passive solar houses and 60 energy conservation houses, but the demand for passive solar has been overwhelming. We are now planning 60 passive solar and 20 energy conservation houses."—Dave Painter, Paintridge Design and Development, Inc., Davis, CA.

This 80-unit subdivision features passive solar homes that are expected to use only one-fourth the energy of a standard home. Both heating and cooling are provided by these passive homes. The heating is by direct gain and cooling is by night ventilation. Thermal storage was included by using filled concrete block interior walls.

The designer's criteria included: an attractive conventional look, affordable price, and maximum performance. The houses were designed to work well without owner participation, a key factor for wide acceptability. The first step was development of an energy efficient shell, with 2"x6" studs, overhangs for summer shading, good ventilation (including security locks that allow the windows to be open), and good orientation. After this was done simple passive features were added to increase solar heating and natural cooling.

The model home is used to showcase other energy conservation features, insulated drapes for example, and these can be added to the home if the buyer wishes. This development is an excellent demonstration of passive solar design in production housing.

Larchmont Summerfield, Unit II, Sacramento, by M. J. Brock & Sons, Inc., Sacramento

This single-family development began with careful orientation of streets for good solar access. Reiners and Hayes, solar planning consultants, worked closely with Brock designers to provide north-south lot orientation on 80 percent of the lots.

Then the passive house plan was developed, beginning with good orientation of windows for solar gain, cross ventilation for nighttime cooling, and wide overhangs for summer shade. To this, thermal mass was added: as a large masonry wall in front of the south windows, tile on slab in the entry, and linoleum on slab in the kitchen and family room to allow the mass to work for heating and cooling.

These "Sundial" homes come complete with low-energy-use appliances, including a solar-assisted water heater and high-sensitivity thermostats throughout the house for heating. A Casablanca fan supplements natural cooling. The fireplace, fed by external air, also incorporates a built-in heat exchanger to assist in heating the home.

The house is expected to reduce yearly total utility bills 50 to 60 percent compared to a standard home of similar size, for an annual saving of $300 to $400.

South Bay, San Diego, by Time for Living of San Diego

The 176-home "Casa Major" subdivision is one of the largest in the nation to include solar hot water systems as a standard feature. Each of these affordable homes includes a solar system composed of two collectors, a pump, controller and a 66-gallon storage tank.

The solar units, supplied and installed by Solar Transition, Inc. of San Diego, have qualified for FHA and VA financing and are eligible for the CAL-SEAL tax credit labeling program.

The developer has been very pleased with the solar hot water systems and feels that they give him a competitive marketing edge over similar homes without solar.

University City, San Diego, by Time for Living of San Diego

This 105-unit subdivision was started in 1977 and completed in 1979. The developers provide a solar hot water system in all houses. The basic system includes 2 or 3 collector panels (depending on orientation), a pump, controller, and 66-gallon storage tank. The system cost less than $1,500 installed, before the solar tax credit was taken. Collectors are flush mounted on most roofs and recessed to look like a skylight on tile roofs. They are not obtrusive.

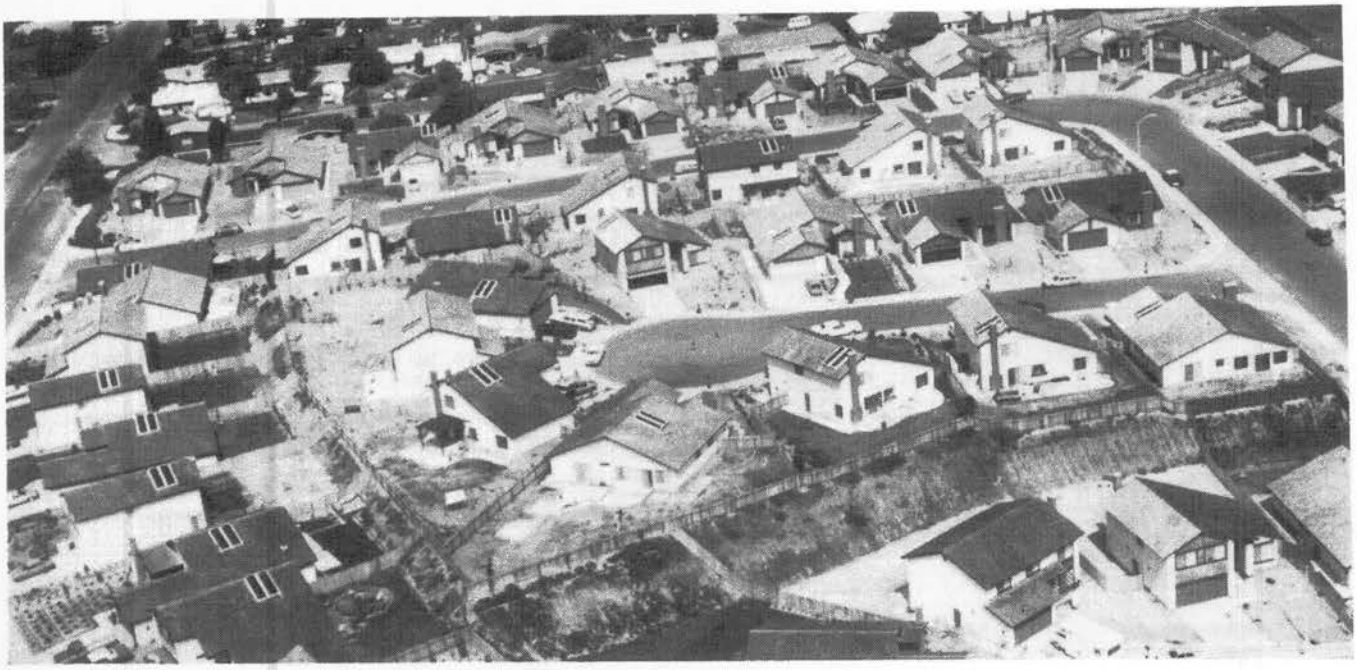
The systems were installed by Sun Gold Solar of San Diego and another solar contractor. At the end of 1979, Time for Living had installed solar water heating on more than 700 new homes. All of the completed systems have qualified for FHA and VA loans and are eligible for the CAL-SEAL tax credit labeling program.

Jackson Square, San Jose, by Jackson Homes of San Jose

The 119-unit single-family home project in San Jose, Jackson Square, includes three and four-bedroom homes with solar water heating as a standard feature in all units.

The solar energy systems consist of two or three copper collectors and an 80-gallon solar storage tank, as well as a controller which contains an internal microprocessor to regulate water temperature. American Solar Engineering and Foremost Plumbing Company are responsible for the packaging and installation of the solar system units. Developer Tom Jackson noted in a recent trade magazine article, "Because of the solar units, people are drawn in to look at the development." He added, "By putting solar on houses I make money."

Time for Living Subdivision, Cardiff by the Sea

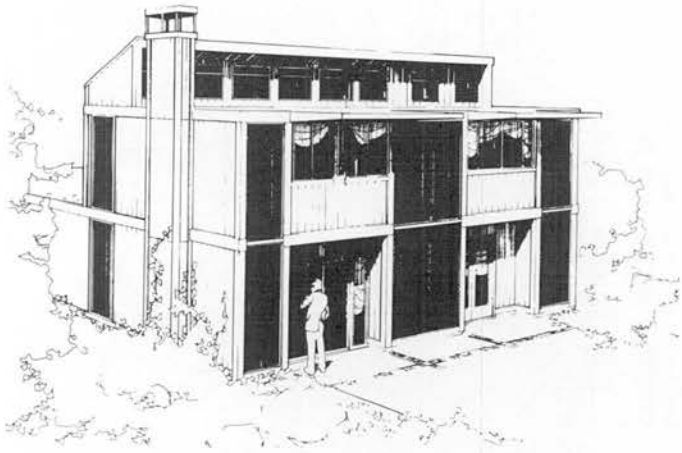


Suntree, Thousand Oaks, by Hollyfed, Inc. of Ventura

Located in the eastern end of Ventura County, Suntree is a 183-unit single-family home project. The homes include three to five bedrooms and are situated on 87 acres with the majority of homes adjoining an open park-like area.

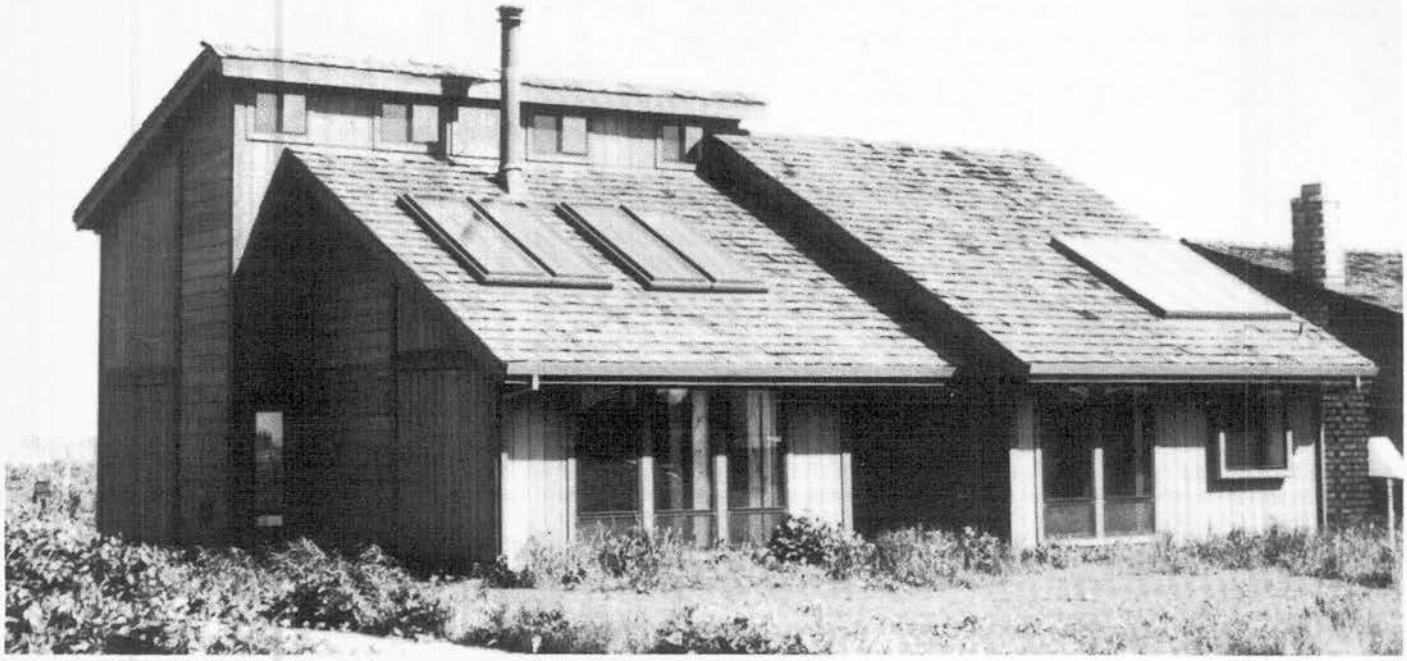
A solar hot water system with a 106-gallon capacity is a standard feature, making Suntree the largest residential development in 1979 to utilize a solar system in every home. A thermal analysis recently indicated that the system, on average, will meet approximately 68 percent of a family's annual hot water requirement.

Jon B. Hedberg, executive vice-president of Hollyfed, stated that nearly all the new homes in the project were bought within five weeks of the development's opening. He added, "One of the reasons behind our excellent sales is the fact that each of the 183 homes is equipped with solar."



Winner, 1979 California Passive Solar Design Competition, Single-Family Design Category. Direct gain, passive solar heating. Architect/designer: Sinan Sabuncuoglu and Jim Fong, Oakland, CA.

"Buyers are pleasantly surprised at how harmoniously the solar collectors blend in with the tile and shake roofs." Jon B. Hedberg of Hollyfed, at the Suntree Homes dedication, 1979.



CUSTOM HOMES

A custom home design by Paul Fellers, built by Bent Nail Construction, Davis

The single-family detached custom home described here is typical of the many passive solar houses built by Bent Nail Construction. It was commissioned by the designer, architect Paul Fellers. It includes both passive space conditioning and a passive solar water heater.

Proper orientation for the house was easy, thanks to the developer's concern for solar access. All lots in the Village Homes subdivision face south, with solar access protected by the solar covenant shown on page 10. The house shell was built with 2"×6" studs for R-19 insulation in the wall, R-30 insulation in the roof, and slab-edge insulation. Most windows, including four large skylights, are on the south side for good solar collection.

The house features very effective thermal mass, sized for good heating and cooling. The major component of the storage system is a 12'×17'×1½' thick rectangular steel water tank in the center of the house, which also serves as a partition wall and upstairs balcony rail. This tank is augmented by heat storage in the slab under the tile floors of the kitchen, dining, and living rooms. The passive solar system is backed up with a small wood stove and the gas water heater, using a small hydronic system.

Cooling is by nighttime ventilation of the house. Cooling loads were minimized by shading and light colors. Hot water for the house is heated in a flush-mounted, double-glazed passive solar water heater with five tanks.

The house provides 100 percent natural cooling, 90 percent natural heating and 60 percent solar hot water.

Tandem's multi-unit development with hybrid solar systems.

MULTI-FAMILY APARTMENTS/TOWNHOUSES

Suntree Townhouse/Apartment Complex, Davis, by Tandem Associates, Inc. of Davis

This multi-unit development began with a determination to provide solar energy for space heating and domestic water heating as well as natural cooling. It meets this objective with a clever passive/active hybrid system based on the developer's earlier solar work in single-family housing.

The development began with good site orientation to provide solar access for each of the 95 units in the complex. Basic passive solar features were then added, putting most windows on the south, shading with overhangs and wing walls, using flow-through ventilation, and choosing light-colored roofs. In addition, the design featured a number of advanced energy conservation measures well in excess of even the strict California code requirements.

Tandem's active solar system was added to provide domestic hot water, backup space heating for the passive system, and cooling using night sky radiation. The last is unusual and adds considerably to the cost-effectiveness of the system. A plastic glazing is used on the collectors so that when they are operated at night they provide cooling by radiating built-up heat from the house to the night sky. Warmth or coolness is transferred to the living space by means of a floor slab with coils embedded in it. Additional storage is provided by water tanks. The system is controlled by a custom-designed microprocessor that regulates pumps, valves, and backup heaters. Freeze protection is by draindown.

The system is expected to meet considerably more than 80 percent of the yearly demand for energy for space heating, cooling, and hot water. Total energy bills for these functions should be less than $20 per year, at 1979 local energy prices. The low cost reflects the major conservation and solar features in the building structure as well as the generally lower energy use of apartment tenants compared with single-family households.

Azure-Robinson, Winters, and Estes - San Diego Developments by Ray L. Huffman Energy Management Company of San Diego

Azure-Robinson (52 units), Winters (9 units), and Estes (58 units) are apartment projects by Ray L. Huffman Energy Management Company. The units include solar systems which heat water year-round for the pools and spas, provide domestic hot water, and process hot water for laundry rooms. Some apartments include hydronic space heating through coils in the duct work.

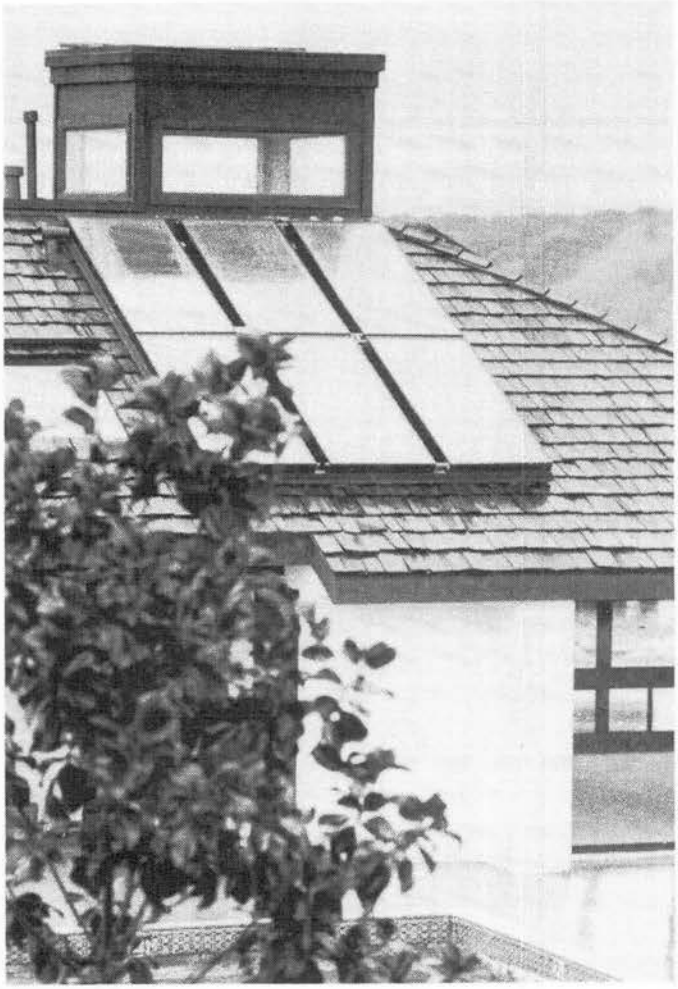
Huffman is involved with numerous solar single-family home tracts, apartments and condominiums in the San Diego area. The types of collector and controls used are varied, and the projects themselves vary in design with passive considerations stressed in each.

Seabluff Canyon Townhomes, Costa Mesa, by The Gregory Company of Costa Mesa

Located off Canyon Drive in Costa Mesa, the 82-unit Seabluff Canyon Townhomes were designed by Harrison/Lorenzini of Costa Mesa. The project features Sunstream solar water heaters and 66-gallon solar storage tanks. Sunlight Energy Systems, Inc. of Costa Mesa is responsible for the installation of the solar systems.

Estimating that Seabluff Canyon Townhomes residents should experience a 50 percent savings in energy costs over more conventionally designed homes, the company president, James Gregory, noted that the annual savings on hot water alone is predicted to reach 75 percent.

Many passive solar features and other energy conservation features were included in the community in addition to the solar assisted hot water systems. Winner of the 1979 Gold Nugget Award from the Pacific Coast Builders Conference, the award to the Townhomes included two categories: "Best Energy Efficient Homes" and "Excellence in Design." The project also received a "Concern Award" from Southern California Gas Company.



Solar panels and skylight on a unit in Vista La Jolla Townhomes, built by Genessee and Nobel of San Diego, California.

BUILDING FOR OPTIONS OR RETROFIT

Even if the builder decides not to include solar water heaters or space-conditioning systems, houses can be made easier to retrofit by orienting them properly, strengthening the roof and bringing water lines to the roof for eventual hookup of a solar system, and ensuring storage space for solar-heated water. Such simple steps can considerably reduce the cost of retrofitting these houses.

The builder may wish to offer a standard option package for the houses. The most promising alternatives are solar water heaters and solar greenhouses. Solar water-heating options can be installed quickly and economically if the house is properly oriented, water lines are extended to the roof and "stubbed," extra roof loading is provided for, and a location for the solar storage tank is provided.

The solar greenhouse for space heating is an excellent retrofit because it is inexpensive and effective. It adds additional living space and also enables the homeowner to grow vegetables in the winter. Many buyers welcome the opportunity to take another step toward self-sufficiency.

An attached solar greenhouse, efficiently and economically retrofitted.

These are some of the retrofits a builder may wish to offer. They will also make good options on new houses for buyers who commit before the houses are finished. These options return a good profit to the builder, and a high tax credit to the homeowner, help keep crews busy during slack periods, and improve the builder's visibility and reputation.

The addition of a solar water heater, either active or passive, is also attractive for a retrofit. The solar system can reduce the homeowner's reliance on non-renewable fuel, provide cost savings, and serve as a very visible statement of the homeowner's commitment toward a solar future.

BUILDERS' CONCERNS

While looking closely at solar systems, builders are moving cautiously because of concerns over: cost, performance, consumer acceptance and liability. These concerns are addressed here.

Cost

The question of cost was addressed above in sufficient detail to dispel some of the myths about the high initial cost of solar. In areas or in homes served only by electricity, solar systems are cost-effective even without the tax credit, and are well worthwhile for the builder, buyer, and society as a whole. Changes in the federal solar tax credit are expected to increase its scope and benefits. In addition, a national Solar Bank may be authorized by Congress in 1980, to make below-market-rate loans on solar energy systems. The Bank would commence operations in 1981.

Performance

Although the pioneers in active solar subdivisions in 1975 to 1977 had some initial problems, these have been resolved. The choice of system type and system installer is still an important one, just as it is with any other appliance or subcontractor. Some solar systems have operated for 30 or 40 years without repair, but some maintenance generally will be required. Mandatory warranties for the state solar tax credit, the bonded warranty carried by some installers, and the CAL-SEAL program also give builders considerable backup if there are performance failures.

Consumer Acceptance

Clearly, the builder must have assurance of consumer interest before using solar technology. Builders are now reporting that consumer demand is increasing and that there appears to be a marketing advantage for homes with solar energy features. There are now more than 120 housing developments in California featuring solar energy as a standard item. The builder who uses solar systems in 1980 and beyond can be assured of sales and can learn from the experiences of builders pioneering in this field.

Liability

Under California law, the builder of a home assumes the liability for all problems associated with the structure and its permanent contents (that is, those items installed at the time of sale) from the time of sale to a fixed period in the future (usually one year), through an implied warranty of merchantability.

Here is how the builder's liability is affected by solar energy systems:

- The normal contractor's bond is unchanged.
- Solar active systems do contain additional components and parts which have their own modes of failure, and their installation can create additional exposure. The warranties issued by solar installers will cover the builder for one year. Some warranties are also backed by a bond.
- The failure of a solar system can induce secondary losses, such as water damage to ceilings, walls, or home contents. Such failures are rare and are covered by normal home insurance.
- The builder in effect guarantees to the buyer that a system will function over its warranty period to its specified operating characteristics. A homebuyer, not satisfied with the builder's "performance" in backing the product, can complain to the State Department of Consumer Affairs or bring an action to the Contractors' State License Board affecting the solar contractor's license. For protection, the builder should consider using TIPSE-certified solar equipment and an experienced solar contractor.

A passive solar home by Sun Energy Builders in Carmichael, California.

SELLING THE SOLAR HOME

Selling a solar home is easy now, and will get even easier as energy prices continue to rise. A recent California Field Poll found that 81 percent of the surveyed public takes the energy crisis seriously and overwhelmingly supports continued tax credits and incentives to speed development of solar devices. Every major increase in fuel prices adds more incentive to buy a solar home.

FINANCIAL CONSIDERATIONS

The capital cost of a solar house should be comparable to that of a conventional energy-wasting house if a good passive or active solar system is used and the tax credits are taken. This is an attractive selling point, particularly when the greatly reduced operating cost is considered.

The use of computer simulations for energy performance predictions allows the builder to estimate fairly accurately the potential savings generated by the solar system(s), particularly for passive systems. In many cases these savings will be substantial, particularly if figured over the lifetime of the house. The California Energy Commission or the various solar associations listed in the "Resources" section, can direct the builder to a solar consultant who offers computer simulation.

PSYCHOLOGICAL FACTORS

Psychological considerations further enhance the attractiveness of a solar home. The builder should emphasize the owner's role in helping our country gain independence from conventional non-renewable imported energy sources. Solar systems can help "inflation-proof" a home's energy systems. The greater comfort of an energy-efficient solar home should also be pointed out. For a passive system, the builder can emphasize the fact that the system will work during a power outage, helping the owner toward further self-reliance.

The builder should also point out the value of a buyer's investment in solar as a means of increasing local employment.

The utilities' recognition programs for builders of energy-efficient or solar homes can emphasize the importance of an energy-efficient or solar home to the buyer.

For example, Pacific Gas and Electric's Premium Energy Conservation Home program (PECH) provides a utility approval of a combination of energy conservation features that reduce total energy use about 25 percent. A PECH home may also qualify for PG&E's "Suntherm" program which provides generous free publicity as well as direct cash payments of $500 to $1,000 per home for passive systems.

San Diego Gas & Electric Company offers an "Energy Conservation Home" award and a builders incentive program based on a point system which encourages the addition of energy efficient features in new homes. A number of points may be obtained by installing passive solar design features such as north-south lot orientation, enlargement of south-facing glass, provisions for roof overhangs and the planting of deciduous trees.

Active solar design features receive points for allowing for future solar retrofits; these features include sufficient roof area for a solar water heater and plumbing accommodations for future solar hot water retrofits.

A similar energy efficiency program is conducted by Southern California Gas Company. Participating builders receive a "CONCERN" award for selecting enough energy conserving features, according to a point system. Unlike the SDG&E program, active solar installations are currently eligible in the program. These include solar water and space heating systems with a gas backup. Also, installation of either of these active solar features provides a majority of the points necessary to qualify for the award.

The same types of publicity can also be generated without utility recognition. Simply prepare publicity materials covering system characteristics, cost, operation, etc., and invite the news media for a visit. With energy in the headlines almost every day, interest is high in solar and conservation programs.

SELLING THE SYSTEM

The seller should carefully explain how the solar system works and what, if anything, the homeowner must do to operate and maintain it. Preparation of such material for the buyer need not be expensive and will go a long way toward making the sale, helping the solar system operate efficiently, and keeping the buyer happy. Instructions should include phone numbers for the buyer to call for additional information or assistance with maintenance or repair.

Some form of meter or display that enables the buyer to monitor the system's performance is desirable. This is a good conversation piece for referral sales in addition to helping catch malfunctions early. However, these meters may cost $150 to $350.

ANSWERING BUYERS' CONCERNS

The buyer may raise other questions about a new solar home. Usually these are limited to concern about: cost and value (appraised and resale), reliability, and operation. It is much better to prepare a comprehensive brochure to answer these questions than it is to answer questions verbally or with general handouts which may not specifically address the system used. This is equally desirable for both passive and active systems. This material should include the following information.

Cost

The cost of the system will often be a concern for the buyer. It will help sell the house and the solar system if the seller clearly shows the initial cost of the system, any operating and maintenance costs, an estimate of monthly and annual savings compared to a traditional house, and the life-cycle savings. It may also be advantageous to calculate and include a figure on the return on the buyer's investment (often 30 percent or more per year).

The CAL-VET program of the State Department of Veterans Affairs offers an increase in its loan ceiling of $7,000 per unit for solar installations. This can be very important in bringing solar houses within reach of moderate income families. Cal-Vet's higher loan for solar is not unique. FHA, VA and Farmers' Home all offer 20 percent higher loan ceilings for solar, which amount now to a $12,000 increase in a loan.

Some lenders are now including monthly energy costs in calculating loan maximums. This might also enable a buyer to qualify for a loan, even if by conventional standards the income loan ratio is a little low.

In addition, the seller should provide information on the solar tax credits, eligibility, costs, and application method. The "CAL-SEAL" program, developed in conjunction with the California Energy Commission (CEC) will help. It provides guidance to builders, installers, and buyers who wish to claim the 55 percent California solar energy tax credit.

The CAL-SEAL form allows the builder or installer of a solar energy system to determine, in a step-by-step manner using flow charts, whether or not a system qualifies for the state tax credit. The CAL-SEAL label signifies, in the opinion of the CAL-SEIA and the CEC, that the installed system meets the technical requirements of the regulations. CAL-SEAL will distribute lists of registered installers to anyone who requests information. More than 300 solar installers now participate in CAL-SEAL.

Reliability

The reliability of the system may also be questioned, so let the buyer know that solar systems have been successfully operated for many years. Explain the various warranties on the system and list the phone numbers to call in the unlikely event something does fail. Discuss the system with the buyer, covering such issues as what to look for, how many years the components are likely to last (15 to 20 years) and what procedures will extend their life.

The builder may also wish to use a solar installer who participates in CAL -SEIA's bonded installation warranty program. This program guarantees material and workmanship and provides someone to resolve problems if the original installer cannot. This can enable installers to qualify for reduced rates on insurance and help satisfy buyers' concerns about reliability.

The Solar/Insulation Unit of the Department of Consumer Affairs can answer any questions about the warranties and assist in complaint handling.

Operation

For many active solar systems, there will not be any tasks for the buyer, except perhaps cleaning or oiling now and then. For passive systems, however, the buyer may have to operate windows, shades and shutters properly. In this case, it is wise to give the buyer a season-by-season description of operations. If possible, this should also cover things not to do as well. Buyers might benefit from a brief explanation of the energy impact of not closing shutters at night in winter (particularly in sky lights) or of not ventilating at night during summer.

This section of the builder's handout should also include a simply written description of proper maintenance of the various elements of the solar systems. This might include oiling hinges, washing drapes or glass, and checking water levels, for example.

SUMMING UP

Solar energy is not an energy resource for the distant future, but is reliable and economical today. Examples and information in this handbook are based on the widespread experiences with solar energy in California made possible through the initiative and efforts of many individuals in the private sector and in government.

Such cooperation is essential in combatting exorbitant fuel prices and the even more serious shortages we face. It is hoped that this handbook will help builders *everywhere*, and also assist the Regional Solar Energy Centers and State offices to work with these builders, with utilities and financial institutions to build and sell energy-saving solar homes.

RESOURCES

This booklet is intended only as an introduction to the many types of solar systems and their advantages. For more detailed information, you should consider buying or obtaining the following books and information packets.

SOLAR DESIGN AND CONSTRUCTION

PASSIVE SYSTEMS

Passive Solar Handbook for California (1980) Kenneth Haggard, Philip Niles, David Wright, David Bainbridge, Denny Long, *et. al.*, California Energy Commission, 1111 Howe Avenue, Sacramento. (Price and exact release date unknown.)
This is an excellent source of passive design information including specific details, performance estimates, and much more.

The Passive Solar Book (1979) Edward Mazria, Rodale Press, Emmaus, PA. $10.95.
One of the better introductions to passive design. A professional edition is also available.

The Passive Solar Catalogs (1979, 1980) David Bainbridge, Passive Solar Institute, P.O. Box 722, Davis, CA 95616.
Passive primers and access to consultants and components, tanks, curtains, etc. First Catalog features new construction in temperate climates, second Catalog features retrofits and cold climate construction. V:I - $7.50, V:II (write for release date and cost).

Natural Solar Architecture (1979) David Wright, Van Nostrand Rheinhold, NY, $7.95.
Another fine introduction to passive design. Hand-printed format is intended to ease the reader into the basics of passive solar design.

ACTIVE SYSTEMS

Solar Heating (1978) Holly Antolini, ed., Sunset Books, Menlo Park, CA. $3.95.
This is beautifully done, inexpensive, and worth having. It covers passive as well as active—but the active section is better.

The Solar Home Book (1976) Bruce Anderson with Michael Riordan, Brick House Publishing, Boston, MA, $9.50.
A bit dated now, but still the classic. Good covering of a variety of active systems; passive systems are covered to a lesser extent.

Present Value (1980) Gigi Coe, Friends of the Earth Books, San Francisco, CA. $5.95.
Originally a State report, gives full descriptions and excellent graphic treatment of a number of active and passive solar systems. Excellent text.

The Guide (1979) Solar Age, Harrisville, NH. $120.
The book is a solar products specification guide and is the most complete catalog of active solar components and information on them. Worth buying if you are planning to do a big solar project. Features regular update service.

SOLAR SUBDIVISIONS

Solar Access (1979) David Bainbridge, *et. al.*, California Energy Commission, Sacramento.
A fine introduction to planning for solar access. A bargain at $1.00.

Village Homes' Solar House Design (1979) David Bainbridge, Judy Corbett, and John Hofacre, Rodale Press, Emmaus, PA. $6.95.
A very intriguing look at the Village Home Solar Subdivision in Davis, CA. Featuring design principles for the subdivision as well as a close look at 43 solar houses. No federal or state support was provided for the development.

SOLAR TAX CREDIT

Solar Tax Credit (1979) California Energy Commission, Sacramento. Free.
A good little pamphlet on the California solar tax credit.

Solar Tax Credit Handbook (1979) M. E. Boylson, CAL-SEIA, Sacramento, CA. $25.
This is the best and most complete handbook available today. It was used for CAL-SEIA's tax credit seminars.

PASSIVE SOLAR HOUSE PLANS AVAILABLE TODAY

Waterwall Passive Solar House, 3 bdrm, 2 bath, 1310 sq. ft. from PSI, Box 722, Davis, CA 95616. $25.

Solarium House, 3 bdrm, 2 bath, 1503 sq. ft. from Positive Technologies, Box 2356, Olympic Valley, CA 95370. $285.

PB-300 Passive Solar House Plan, 3 bdrm, 2 bath, Professional Builder, 5 South Wabash Street, Chicago, IL 60603. $110.

Energy Efficient House, 3 bdrm, 2 bath, 2296 sq. ft., Home Building Plan Service, 2235 NE Sandy Boulevard, Portland, OR 97232. $140.

SOLAR SYSTEM BENEFITS

The Benefits of Solar Water Heating in California (1979) Jerry Yudelson and Ethan Thorman, California Solar Business Office, 921 Tenth Street, Sacramento, CA. Free.

SOLAR INDUSTRY

California Solar Business Directory (1980) Jerry Yudelson and Margaret Kitchin (eds.), California Solar Business Office, 921 Tenth Street, Sacramento, CA. $10 (postpaid).
Comprehensive guide (200 pages) to California-based solar manufacturers, installers, consultants and designers, with an informative text.

SOLAR INFORMATION DIRECTORY

NATIONAL AGENCIES

National Solar Heating and Cooling Information Center (toll free)	(800) 523-2929
Department of Energy (DOE)	
California	
San Francisco	
333 Market Street	
San Francisco, CA 94102	
—Energy Information Center	(415) 556-7328
—Appropriate Technology Grants	(415) 556-1465
Oakland	
—Solar Program Information	(415) 273-4263
Los Angeles	
—General Information	(213) 688-4595

STATE AGENCIES

California Energy Commission (CEC)	
1111 Howe Avenue	
Sacramento, CA 95825	
Solar Office	
—General & Program Information	(916) 920-6011
—TIPSE	(916) 920-6027
Conservation Office	
—General Information	(916) 920-6091
—Load Management	(916) 920-6084
—Pamphlets	(916) 920-7767
—Appliance Efficiency	(916) 920-6114
—Building Standards (residential)	(916) 920-6442
SolarCal Council "SUNDIAL" (Consumer Hotline) 1111 Howe Avenue #315 Sacramento, CA 95825	(800) 952-5670
Solar Business Office (Business Information) 926 J Street, Suite 201 Sacramento, CA 95814	(916) 322-9725

RESOURCES

Contractors State License Board (916) 445-7500
1020 N Street, Sacramento, CA 95814
(Information on Solar Licenses)

Department of Consumer Affairs
1020 N Street
Sacramento, CA 95814
—Solar/Insulation Complaint Line (800) 952-5567
(toll free)

Franchise Tax Board
Solar Tax Credit Information,
Public Lines
From area codes 209, 408, 707, 916, 415 (800) 852-7050
From area codes 213, 714, 805 (800) 852-5711
—Supervising Tax Auditor (916) 335-0426

PUBLIC EDUCATION GROUPS

Center for Solar Energy Applications (408) 227-2939
San Jose State University
San Jose, CA 95195
(Will answer solar questions in the San Jose area)

Northern California Solar Energy Association (NCSEA) (no phone)
P.O. Box 1056
Mountain View, CA 94042

California Solar Energy Association (714) 236-9732
1007 - 5th Avenue, Suite 1020
San Diego, CA 92407

San Joaquin Valley Solar Energy Association (no phone)
3733 E. Iowa Avenue
Fresno, CA 93702

California Energy Extension Service (916) 323-4833
1211 16th Street
Sacramento, CA 95814
(Will handle information requests on passive systems as time allows.)

Foothill Solar Exchange (916) 273-1007
(Nevada County)

Pacific Gas & Electric Company (800) 792-8000
245 Market Street
San Francisco, CA 94106

SOLAR INTEREST GROUPS

California Solar Energy Industries Association (CAL-SEIA) (916) 443-1877
926 J Street, Suite 820
Sacramento, CA 95814
(Sacramento)
including CAL-SEAL program
Bonded Warranty Program Information (213) 785-0418

CBIA—Educational Service Division (415) 981-1069
1225 8th Street or (916) 443-7933
Sacramento, CA 95814
(For builders only)

Solar Energy Advocates, Inc. (916) 442-5352
1107 Ninth Street
Sacramento, CA 95814
(Solar Professional Lobby)

SUNRAE, Grassroots Solar Lobby (916) 448-1198
(Sacramento)
1107 Ninth Street
Sacramento, CA 95814
—Information on legislation

FINANCIAL MARKET

Federal Home Loan Mortgage Corporation (policies) (202) 789-4700

Federal National Mortgage Association (policies) (202) 537-7474

Government National Mortgage Association (policies) (202) 755-5926

Veterans Administration (loans) (202) 393-4120

Federal Housing Administration (loans) (202) 755-5995

Farmers Home Administration (loans—rural areas only) (916) 666-3382

Cal-Vet (solar loans) (916) 920-9721

SOLAR CHECKLIST FOR BUILDERS

1. Energy Conservation

Insulation (wall, floor, attic, perimeter)
Movable insulation (curtains, shutters)
Insulated doors and windows
High-grade weatherstripping and vapor barriers
Caulking for plates, joints and cracks
Cross ventilation
Light-colored roofs
Shaded windows in summer
Flow restrictors
Low-energy-use appliances
Stone fireplace with outside air intake
Energy performance calculation
Landscaping for summer shade/winter sun

2. Space Conditioning

Lot faces close to south (streets run east-west if possible)
Assure solar access

3. Passive Solar

House faces south
Most windows on south side
Interior thermal mass
Overhangs on south/west windows
Solar exposure

4. Active Solar

Freeze protection, leak prevention
Flashing on all roof penetrations
Extra insulation on all hot lines and storage tanks
Field test of controls and equipment

5. Hot Water

Adequate solar exposure
Sized to meet demand
Extra insulation on all hot water lines and storage tank
All penetrations flashed, caulk glazing
Pressure test of systems
Test of controls and pump
Assured solar access

6. Tax Credit

Builder's credit (optional for California credit)
Buyer's credit (state and/or federal)
Passive solar credit (state only)

7. Other Incentives

Solar loan eligibility (utilities or federal)
Utility solar rebate (passive systems)
Utility recognition program