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ABSTRACT

Projects being carried out by the private sector involving the use of solar energy for heating and cooling buildings are profiled in this report. A substantial portion of the data were collected from a broad cross-section of the building community. Data collection efforts also involved the canvassing of the nearly 200 trade and professional societies and organizations representing the various segments of the building community. Each project profile identifies, when possible, the status of the activity, the principal person to be contacted for further information, and other support personnel. An index of projects, organizations, and project personnel is included. (Author/MLF)

SOLAR HEATING/COOLING OF BUILDINGS: Current Building Community Projects

An Interim Report

Prepared by the
Committee on
Solar Energy in the Heating and Cooling of Buildings
of the
Building Research Advisory Board
Commission on Sociotechnical Systems
National Research Council

National Academy of Sciences
Washington, D. C.
1974

$2.50

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The members of the committee selected to undertake this project and prepare this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. Responsibility for the detailed aspects of this report rests with that committee.

Each report issuing from a study committee of the National Research Council is reviewed by an independent group of qualified individuals according to procedures established and monitored by the Report Review Committee of the National Academy of Sciences. Distribution of the report is approved, by the President of the Academy, upon satisfactory completion of the review process.

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Inquiries concerning this publication should be addressed to: The Executive Director, Building Research Advisory Board, Commission on Sociotechnical Systems, National Research Council, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

BRAB COMMITTEE ON SOLAR ENERGY IN THE HEATING AND COOLING OF BUILDINGS

[illegible]

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[illegible]

[illegible] Associates, New York, New York
[illegible], Assistant to the Managing Director, Air-Conditioning and Refrigeration Institute, Arlington, Virginia
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FOREWORD

The building community, which includes all those who are involved in designing, planning, constructing, producing, manufacturing, operating, and maintaining the built environment, is an extremely complex and diverse group of industries, professions, and trades. Building-related research and development often is undertaken by private research institutions and universities, sometimes under grants and contracts from the National Science Foundation (NSF), but much of it also is carried out by builders, contractors, and professionals and by manufacturers and fabricators of building materials, products, components, and systems.

Thus, in its efforts to make the total national solar energy effort as effective as possible, the NSF Research Applications Directorate of Research Applied to National Needs (RANN) asked that the Building Research Advisory Board (BRAB) assist it in determining the general nature and character of nonfederally supported building community activities concerned with the solar heating and cooling of buildings. In response to this need, BRAB has endeavored to assist RANN-NSF by establishing a communications link between it and the private sector of the building community and a first step in this effort has been to locate and collect for RANN as much relevant information on private solar heating and cooling research and development activities as the limited time and funds allow. The BRAB effort is being guided by the Committee on Solar Energy in the Heating and Cooling of Buildings and in this interim report the Committee presents the data it has collected thus far on current solar energy research, development, and construction activities being carried out by the private sector. In subsequent reports the Committee will provide RANN-NSF with additional data as well as its findings, conclusions, and recommendations concerning the nature and character of the building community's activities in and attitudes toward the field of solar heating and cooling of buildings, the building community's expressed research needs that might be benefited by NSF support, and the most cost-effective means of disseminating information generated by NSF-supported research to potential users. In addition, BRAB will update the 1964 BRAB Building Research Institute publication, Solar Effects on Building Design.

This report has been reviewed by representatives of the Commission on Sociotechnical Systems, as well as by the Board, and is approved for transmittal to NSF.

The Board gratefully acknowledges the work of the Committee and those individuals and organizations in the building community who have so generously contributed relevant information.

Herbert H. Swinburne, Chairman
Building Research Advisory Board

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I

INTRODUCTION

Background

The Research Applications Directorate of Research Applied to National Needs of the National Science Foundation (RANN-NSF) is responsible for stimulating the development and widespread use of solar energy for heating and cooling buildings and has established an ongoing program of grant-support for research in the field. To broaden its knowledge of research and development efforts related to solar heating and cooling of buildings, particularly those that are not federally supported, RANN-NSF requested that the National Academy of Sciences-National Academy of Engineering-National Research Council (NAS-NAE-NRC) assist it by establishing a mechanism for identifying and maintaining liaison with those in the private sector who have undertaken projects on their own initiative. In response to this request the NAS entered into a contract with NSF and charged the Building Research Advisory Board (BRAB) of the NRC Commission on Sociotechnical Systems with establishment of a Committee on Solar Energy in the Heating and Cooling of Buildings to carry out the required program.

Purposes of the Program

The scope of services to be provided RANN-NSF under the guidance of the BRAB Committee reflects RANN's interest in the development of a mechanism to assure that nonfederally supported and federally supported solar energy application efforts are complementary and through which methods can be found to respond to identified needs. Specific activities being undertaken by the Committee include the following:

1. Identifying research, development, and applications programs in the nonfederal sector that involve the use of solar energy for heating and cooling buildings; characterizing these building community activities to the degree possible, consistent with proprietary interests; and reporting on specific activities on a semiannual basis

2. Generating periodic statements of supportive research needs as perceived by the private sector that might be used as a guide by RANN in its solar energy program planning

3. Exploring alternative means for dissemination of information on the utilization of solar energy for heating and cooling buildings developed through RANN-supported projects to potential users in the private sector and providing RANN with guidance in establishing a cost-effective means of information dissemination, with reference to specific audiences (elements of the building community) and modes of distribution tailored to meet the needs of particular users

4. Updating the 1964 BRAB Building Research Institute publication, Solar Effects on Building Design, with consideration being given to subject areas such as solar radiation and man, solar energy conversion techniques, solar energy economics, architectural considerations, and research

Scope of the Report

The purpose of this interim report is to transmit to RANN-NSF descriptive profiles of projects involving the use of solar energy for heating and cooling buildings. It includes a substantial portion of the data collected thus far from a broad cross section of the building community; however, it is not intended to be all-inclusive and additional data will be forthcoming as the program continues.

It must be noted that the mention of any particular project, organization, person, product, system, or material does not constitute or imply any endorsement by the Committee or the National Academy of Sciences-National Research Council-National Academy of Engineering and that no attempt has been made to evaluate the data submitted. In addition, while the intent of the program has been to report on non-federally supported activities, a number of the persons, companies, and organizations identified in this report are engaged in both federally supported and independently supported solar energy activities and in these cases, federally supported activities are noted in order to provide broad coverage.

Conduct of the Study

The information collection effort resulting in this report, as well as other activities mentioned, have been and are being conducted under the auspices and guidance of the BRAB Committee on Solar Energy in the Heating and Cooling of Buildings composed of individuals noted for their knowledge of solar energy technology and appointed in accordance with established procedures of the National Research Council.

While the in-house resources of BRAB (e.g., the members of the Board itself and its Building Industry Manufacturers Research Council, Federal

Construction Council, and Building Research Institute) have been used to identify ongoing research dealing with solar energy, data collection efforts also have involved the canvassing of the nearly 200 trade and professional societies and organizations representing the various segments of the building community. These organizations were called upon to ask their memberships to identify those conducting research and development activities in the area of solar energy and, once identified, the individuals or firms were contacted by BRAB during the summer of 1974 in an effort to obtain detailed information on the scope and status of their activities.

While canvassing of the private sector will continue throughout the program and information gathered earlier will be continually updated, the initial canvass has been completed, relevant solar energy projects identified, and this interim report containing synoptic profiles that characterize and detail ongoing activities prepared for transmittal to RANN.

Organization of the Report

This report (the first of several to be prepared during the course of the program) is divided into two main sections this introduction and a series of project profiles. An index of projects, organizations, and project personnel also is included.

Each project profile identifies, when possible, the principal person to be contacted for further information as well as other support personnel. When obtained, the status of the activity is noted; however, such information was obtained in mid-1974 and may no longer be accurate.

II

PROJECT PROFILES

Research and Development

1 COMMERCIAL OFFICE BUILDING

Donald W. Pulver, Executive Vice President
Oliver Tyrone Corporation
1 Oliver Plaza
Pittsburgh, Pennsylvania 15222
412/281-7400

Phase I of this three-phase experimental program to develop a design for an energy-saving solar-powered high-rise office building involved

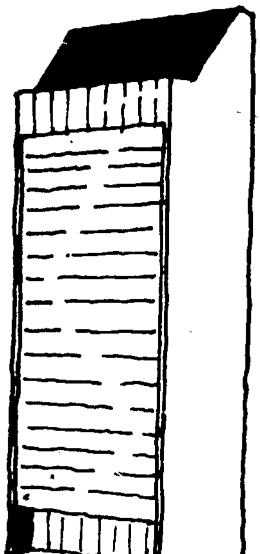

FIGURE 1 Conception of energy-saving high-rise office building.

building a 20-square-foot, 1-1/2 story mock-up to be used as a learning model (cost--$30,000). During Phase II, a 30-square-foot, 2-1/2 story demonstration building will be erected (cost--$90,000); completion is expected in spring 1975. Phase III, not yet funded, will involve construction of a 6- to 10-story building designed to minimize heating and air-conditioning needs. Double-glazed clear-glass-covered collector cells made of coated-aluminum plates with integrated fluid-carrying channels will be used to gather solar energy striking the building facade and roof.

Other participants include PPG Industries, Inc., the Aluminum Company of America, and Standard Oil Company (Ohio).

2 DEMONSTRATION MOBILE HOME

Atif S. Debs
Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30302
404/894-3411

This study is being conducted to determine whether a combination of roof-mounted flat-plate solar collectors and underfloor collapsible thermal storage tanks in a mobile home could provide 50 percent of the total heating requirements.

3 HIGH-RISE OFFICE BUILDING, NEW YORK CITY

R.A. Bell
Massachusetts Institute of Technology
Energy Laboratory
Cambridge, Massachusetts 02139
617/253-1000

This study is being conducted to determine the feasibility of using solar energy to heat and partially cool the proposed 80- to 90-story Citicorp headquarters building. The possibilities of mounting solar collectors on the upper 40 stories and of using solar-powered dehumidification to provide up to 30 percent of the total load are being considered.

Other participants include Consolidated Edison Company and Cushman and Wakefield.

4 INSTITUTIONAL CONSTRAINTS

Jerome Weingart and Richard Schoen
University of California, Los Angeles
Los Angeles, California 90007
213/825-4321

This Ford Foundation Energy Policy Project is expected to result in a description of institutional constraints to the implementation of solar heating and cooling technology in building. Report publication is scheduled for fall 1974.

5 PROJECT SAGE

Edgar S. Davis
California Institute of Technology
Environmental Quality Laboratory
Jet Propulsion Laboratory
Pasadena, California 91109
213/354-4321

This research project for the Southern California Gas Company and supported in part by RANN-NSF is designed to assess the feasibility of designing a commercial solar-energy water heater for use in apartment buildings in southern California. During the feasibility assessment portion of the study, completed in June 1973, a 3-story, 32-apartment building with recreation room and underground parking was used, and alternative systems were analyzed to determine their potential for solar-energy application. To demonstrate feasibility, construction of apartment units using the best systems is planned; design of the first 10 units is scheduled to begin in 1974.

Other participants include Richard Schoen, School of Architecture, University of California, Los Angeles.

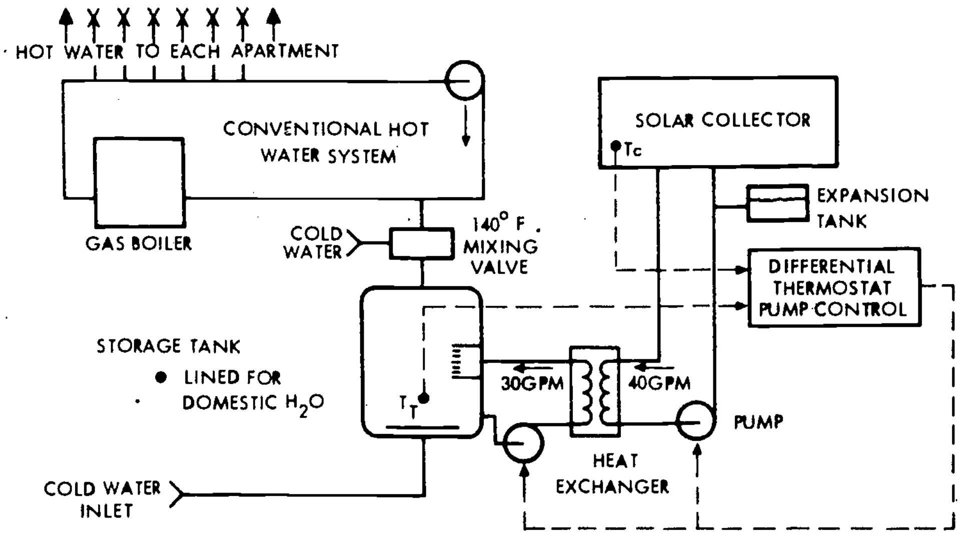

FIGURE 2 Solar-assisted gas energy water heater.

6 SOLAR CLIMATE CONTROL

Joan Berkowitz
Arthur D. Little, Inc.
20 Acorn Park
Cambridge, Massachusetts 02140
617/864-5770

This three-phase, two-year study is being sponsored by more than 80 firms. Phase I involves identification of successful businesses in the solar-climate-control industry and determination of prerequisites and methods for integrating them into the building industry. During Phase II, hardware will be evaluated and detailed marketing plans formulated. The participating firms will collaborate during Phase III to implement the marketing plans.

7 SOLATERRE SYSTEM

William B. Harris
Texas A&M University
Department of Chemical Engineering
College Station, Texas 77843
713/845-3361

Work is being conducted to identify opportunities for application of the newly developed Solaterre system concept that employs a patented solar collector to heat large quantities of well water during warm weather. The warm water then is stored in an underground reservoir and distributed during winter to houses and buildings in a community. The system concept also provides for cooling water with spray ponds during cold weather and storing it for distribution during warm weather.

Other participants include Richard R. Davidson, Department of Chemical Engineering, Texas A&M University, College Station.

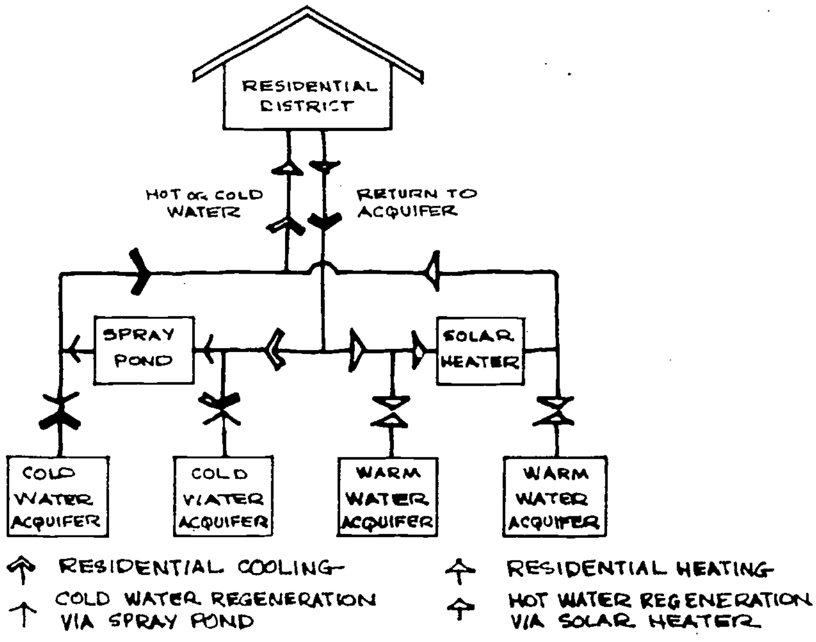

FIGURE 3 Schematic of Solaterre solar-energy system.

8 SOLAR TEST HOUSE

Charles F. Sepsy
Ohio State University
Department of Mechanical Engineering
Columbus, Ohio 43210
614/422-6208

This three-year experimental program, jointly sponsored by Ohio State University and the Homewood Corporation, is expected to result in an assessment of the technical and economic practicality of utilizing solar energy in residential buildings. A test house, scheduled for completion in August 1974, incorporates currently available materials, energy-saving design features, and solar-energy collectors for heating and cooling. Built-in instrumentation measures and records complete inside and outside environmental data.

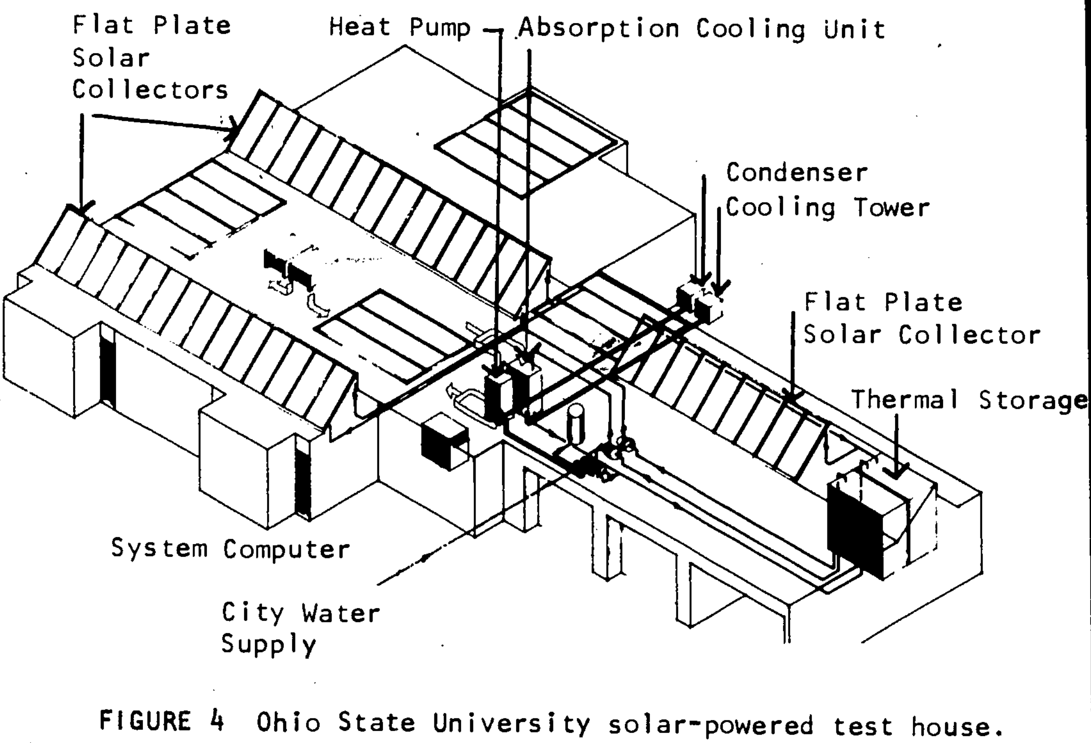

FIGURE 4 Ohio State University solar-powered test house.

Built on the Ohio State Fairgrounds, the 4-bedroom, 2-1/2-bath test house encloses 2,700 square feet. Exterior walls are only 3 percent window and four open courts provide for interior lighting. Roof-mounted water/glycol-cooled flat-plate solar collectors, two 2,000-gallon underground tanks, and an Arkla absorption-type unit powered by solar collectors are used. Electric heaters supplement the system.

Other participants include C.D. Jones, G. Clark, R. Devore, and S.A. Mumma, Ohio State University, Columbus.

Design and Construction

1 BOTANICAL GARDEN BUILDING, NEW YORK CITY

Thomas S. Elias
Cary Arboretum
New York Botanical Garden
Bronx, New York 10458
212/933-9400

This 2-story, 35,000-square-foot building, designed to use solar energy for heating, cooling, and hot water as well as other unique technologies for conserving energy and recycling wastes, will house research laboratories, offices, a herbarium, and an experimental greenhouse. Heat will be supplied by 6,000 square feet of roof-mounted flat-plate glycol-cooled solar collectors for storage in basement compartmented tanks. Supplementary heat pumps will provide back-up.

Other energy-conserving design features include: a greenhouse that will provide plant-generated oxygen and humidity for distribution into the building; a sod-covered roof; earth-banked walls; northwind-sheltering trees; thick masonry walls; double-glazed windows with shutters for use at night to reduce heat loss; extra large windows on the south and east walls to admit sun's warmth; rainwater collection; and task lighting. This combination of systems is expected to decrease total energy consumption by 35 percent, utility energy consumption by 75 percent, and water consumption by 35 percent.

Other participants include Malcolm B. Wells, Architect, Cherry Hill, New Jersey, and Fred Dubin, Dubin-Mindell-Bloome Associates, Consulting Engineers, New York, New York.

2 COMMUNITY COLLEGE BUILDING, DENVER, COLORADO

John D. Anderson, AIA
The A-B-R Partnership, Architects
1200 Walnut Street
Denver, Colorado 80204
303/825-8123

This 1,300-foot-long general-purpose college building will enclose 278,815 square feet of space and will feature: 50,000 square feet of roof-mounted water/glycol-cooled solar collectors facing south at 60 degrees to the horizontal; three underground storage tanks with a total capacity of 400,000 gallons; heat pumps to supplement the system; and other energy-conserving features including redistribution of people- and lighting-generated heat, heat extraction from exhaust fans, a solar-energy-heated hot water supply, double-glazed windows, and extra building insulation. Completion is expected in summer 1976.

The solar system is expected to cost 8.78 percent or $736,780 more than a conventional system; however, a 21 percent fossil fuel saving is anticipated. The return on the system investment is estimated at less than 11 years and by 1990 fuel saving is expected to amount to $90,000 per year.

Other participants include Bridgers & Paxton, Mechanical Engineers, Albuquerque, New Mexico; Sol Flax & Associates, Electrical Engineers, Denver, Colorado; and Robert H. Kula, Director, Planning and Development, Community College of Denver.

3 CONFERENCE CENTER, ROCKEFELLER CENTER, NEW YORK

Jagdish Prasad
Syska & Hennessy, Inc., Engineers
110 West 50th Street
New York, New York 10020
212/489-9200

Preliminary plans for this 1.2-million-square-foot center call for solar collectors to be utilized for heating and, possibly, for cooling. Also being considered is a heat recovery system for collecting, storing, and reusing excess energy from surplus interior heat.

The center is to be built on the 12th floor roof of the existing RCA Building in downtown New York City. To provide partial heating 3,500 square feet of water-cooled flat-plate solar collectors are to be mounted on the roof of the center. The system also will include 7,000-gallon storage tanks and is estimated to cost $150,000 more than a conventional system. It is anticipated that construction will begin in 1975.

Other participants include Ford & Earl Design Associates, Architects, New York, New York.

4 DECADE 80 SOLAR HOUSE, TUCSON, ARIZONA

Arthur Kotch, Architect
6440 Hillcroft Street
Houston, Texas 77036
713/771-2123

Sponsored by the Copper Development Association, this project involves the construction of a 4-bedroom, 3-bath, 3,200-square-foot solar-energy demonstration house designed for energy conservation. A 2,000-square-foot water-cooled flat-plate solar collector, glass skinned and integrated with a copper roof and copper tubing for transport, is used in conjunction with a 2,500-gallon storage tank and two 3-ton solar-powered Arkla absorption units with a cooling tower. Energy savings are estimated at 60 percent. The prototype is expected to be completed during 1975.

Other participants include TRW, Inc., Consultants, Redondo Beach, California.

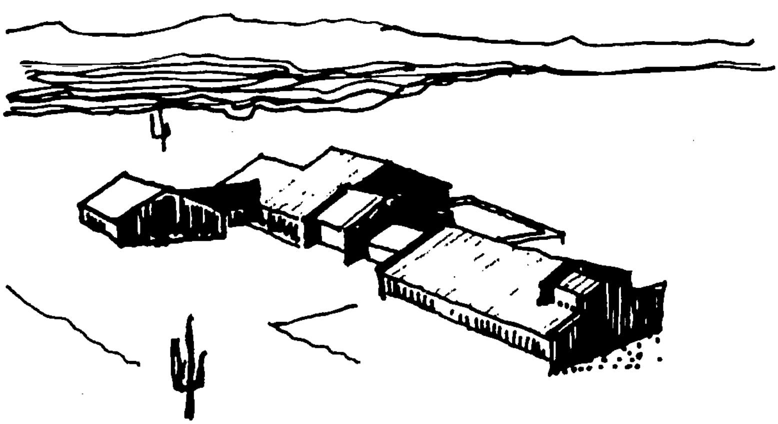

FIGURE 5 Copper Development Association Decade 80 solar house.

5 DEMONSTRATION HOUSE, ALLENTOWN, PENNSYLVANIA

Robert Romancheck
Research and Technical Service Department
Pennsylvania Power and Light Company
Allentown, Pennsylvania 18101
215/821-5151

Designed to conserve energy, this typical subtropical 2-story, 3 bedroom, 1-1/2 bath, 1,600-square-foot house was built to determine "realistic energy-optimization possibilities." The design goal was to decrease the energy requirements of an equivalent all-electric house by from 33 to 50 percent at a target cost of $35,000.

A vertically mounted fence-style water/glycol cooled flat-plate collector (in 3-foot by 3-foot or 2-foot by 4-foot modules) is used to gather solar heat for storage in a 1000-gallon tank.

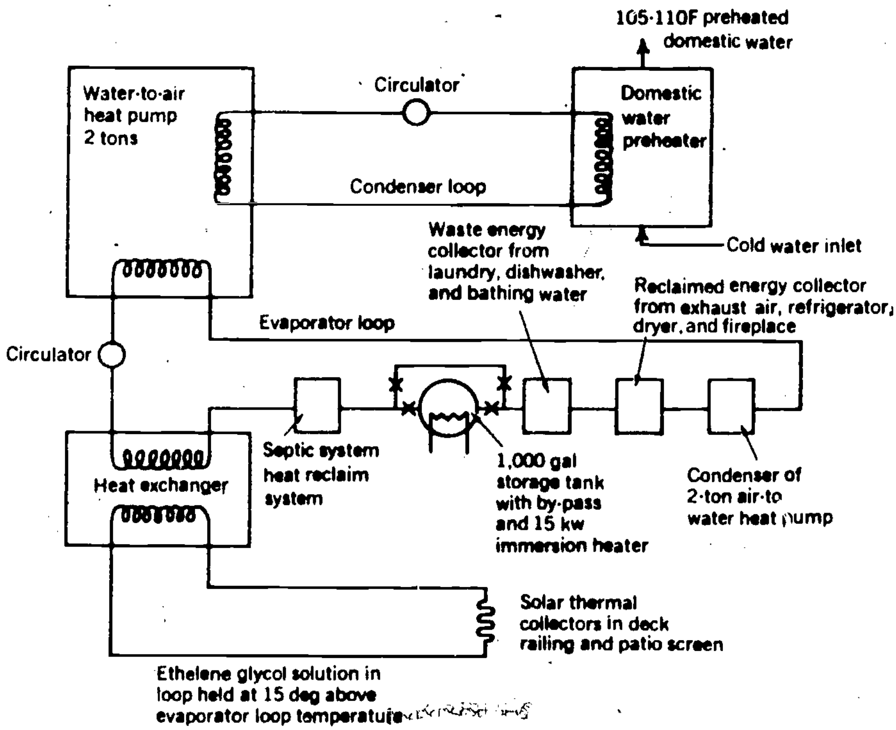

FIGURE 6 Schematic of energy-conserving heating and cooling system for Allentown demonstration house.

Two heat pumps and a 15-kW electric immersion heater in the storage tank supplement the solar energy. Heat also is recoverd from the septic tank, bath water, refrigerator, laundry, and dryer. Evaluation is to be completed and a report published in 1975.

Other participants include the Franklin Institute Research Laboratories, Consultants, Philadelphia, and Donald W. Duncklee, AIA, Allentown, Pennsylvania.

6 DEMONSTRATION HOUSE, HENNIKER, NEW HAMPSHIRE

Douglas Wilke, Architect
38 Roosevelt Avenue
Glen Head, New York 11545
516/759-9050

An energy-conserving 1,000-square-foot single-family house (intended to sell for approximately $25,000 including land) is being built to demonstrate solar-energy heating and air-dehumidification cooling. Energy will be supplied by 700 square feet of roof-mounted air-cooled flat-plate solar collectors. Dehumidification of incoming air will be achieved by scrubbing with triethylene glycol, a process widely used in industry and currently being adapted for residential cooling. Prototype equipment will be used in the demonstration house.

Other participants include Erwin Lodwig, Niagara Blower Company, New York, New York, and George Löf, Solar Consultant, Ft. Collins, Colorado.

7 DEMONSTRATION HOUSES, SAN DIEGO, CALIFORNIA

Terrance R. Caster, President
Energy Systems, Inc.
634 Crest Drive
El Cajon, California 92021
714/440-4646

To develop and demonstrate a packaged solar-energy system for purchase and installation by local builders and heating/ventilating/air-conditioning contractors, seven single-family houses are being built with integrally roof-mounted air-cooled solar collectors to provide for space heating. Thermal storage will be in a below-grade rock pile and various solar-collector/heating-system configurations will be applied to determine the optimal design for the package system. Eventually intended for nationwide distribution, the system is expected to provide 50 percent of the space heating for houses of up to 3,000 square feet.

8 DEMONSTRATION HOUSE, ATASCADERO, CALIFORNIA

Kenneth Haggard
California Polytechnic State University
San Luis Obispo, California 93401
805/546-0111

This demonstration of the patented Skytherm process of solar-energy control through absorption and reradiation via roof ponds involves a single-family, 3-bedroom, 2-bath, 1,000-square-foot house. On a cold day solar energy is absorbed by and stored in ponds of water on the roof and warmth is reradiated into the house; at night, insulated panels slide over the ponds to prevent radiant loss. The process is reversed for warm weather cooling (i.e., the ponds are uncovered at night to permit energy loss and covered during the day to prevent energy absorption). Construction is complete, and evaluation of the house is in progress with support from HUD.

Other participants include Harold Hay, the owner of the house and inventor of the Skytherm process.

9 ENERGY-CONSERVING HOME, TIJERAS, NEW MEXICO

Robert G. Reines
ILS Laboratory
Star Route 103
Tijeras, New Mexico 87059
505/281-5191

This energy-conserving house was built by ILS Laboratory, a group of engineers and scientists interested in energy-conservation designs. The igloo-type structure is 31 feet in diameter and is heavily insulated. Ground-mounted, water/glycol-cooled flat-plate solar collectors provide 100 percent of the heating requirements and an underground tank is used for storage. The house is said to consume only 10 percent of the thermal energy required by an equivalent conventional house.

10 OLD MILL RESTORATION, PROVIDENCE, RHODE ISLAND

Ronald Beckman
Research and Design Institute
P.O. Box 307
Providence, Rhode Island 02901
401/861-5390

A 125-year-old river mill is being restored to demonstrate the benefits of natural energy use. Solar, wind, and water power will be used to supply building needs without disruption of aesthetic and cultural surroundings.

Roof-mounted solar collectors will supply heated water to a reservoir for distribution by utility-powered electric heat pumps. Photovoltaic collectors and wind- and water-powered generators will supply direct current for the lighting system. Alternate reserve systems will be included and studies will be made to determine human reactions to the environment.

Other participants include Brown University faculty and students.

11 RESEARCH INSTITUTE LABORATORY, BOULDER CITY, NEVADA

Robert Fielden, Architect
Jack Miller & Associates
522 E. Twain Avenue
Las Vegas, Nevada 89109
702/735-5222

Solar-energy collectors will be used to heat and cool the new 6,374-square-foot facility of the University of Nevada. Energy will be gathered by 6,000 square feet of roof-mounted flat-plate solar collectors for storage in two 10,000-gallon tanks. An electric immersion heater will provide back-up heat, cooling will be achieved with solar-powered absorption chillers, and several energy-saving design techniques will be employed. Funding for the $648,000 project has been provided by the Desert Research Institute, the Fleishmann Foundation, and Mrs. Sulo Maki.

12 RESIDENCE, GUILFORD, CONNECTICUT

Donald Watson, AIA
Box 401
Guilford, Connecticut 06437
203/453-6388

Using energy-conserving design and a solar collector, this house was designed and built for a private client. Energy-conserving techniques include optimum orientation, shading, insulation, window shuttering, and heat recovery from refrigerator coil and sewage tank. The 2-story, 1900-square-foot house features 456 square feet of water/glycol-cooled flat-plate collectors integrally mounted in roof. Enough thermal storage for 1-1/2 days of operation is provided by 2,000-gallon storage tanks. An oil-fired water heater supplements the solar-energy system.

Other participants included Everett Barber, a solar engineer and the owner of the residence.

13 RESIDENCE, SHANGHAI, WEST VIRGINIA

Paul Richard Rittleman, AIA
Burt, Hill & Associates, Architects
610 Mellon Bank Building
Butler, Pennsylvania 16001
412/285-4761

Designed to conserve energy this 2-bedroom, 2-bath, 1,400-square-foot, 3-level house features 588 square feet of water/glycol-cooled flat-plate solar collectors, integrally mounted in the roof structure at a 45 degree angle. Storage at two temperature levels is provided by two tanks, one 2,400 gallons and the other 400 gallons. An oil-fired water heater supplements the system which is designed for the future addition of an absorption air-conditioning unit. Other energy-conserving design features include triple glazing in windows, an air-lock entrance, and a central fireplace.

Other participants include Mrs. A.N. Wilson, the owner of the house.

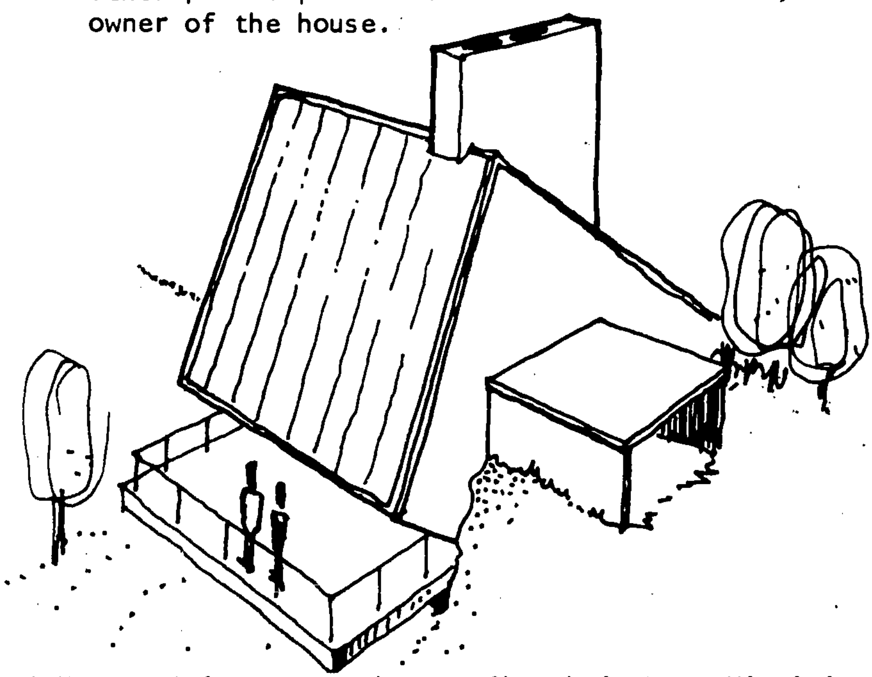

FIGURE 7 Solar-energy house, Shanghai, West Virginia.

14 RETROFIT DEMONSTRATION HOUSE, DENVER, COLORADO

Richard L. Crowther
500 Cook Street
Denver, Colorado 80206
303/388-1875

This existing 2,000-square-foot house was remodeled to demonstrate such passive energy-conservation techniques as control of solar absorptive surfaces by shading, control of surface coating absorptivity, optimum window areas, and use of natural ventilation.

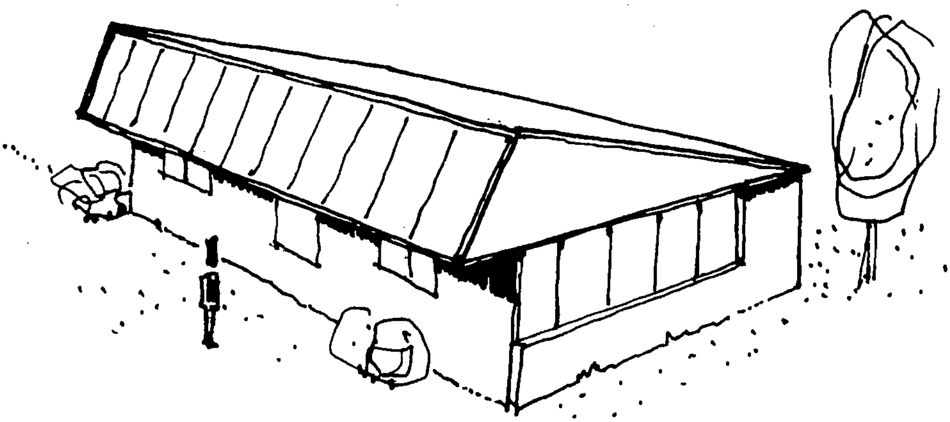

FIGURE 8 Retroffitted house for solar-energy use.

15 SCHOOL SCIENCE BUILDING, McLEAN, VIRGINIA

Arthur Cotton Moore, Architect
1214 - 28th Street, N.W.
Washington, D.C. 20007
202/337-9083

Solar energy will be used to heat and cool the new 7,000-square-foot Madeira School science building. Of the estimated building cost of $400,000, approximately $30,000 is for the solar collector system including 4,500 square feet of roof-mounted flat-plate water/glycol-cooled solar collectors and a 10,000-gallon insulated storage tank. An oil-fired boiler will provide supplementary heating. Construction is expected to be completed in summer 1975.

Other participants include Flock & Kurtz, Engineers, Washington, D.C.

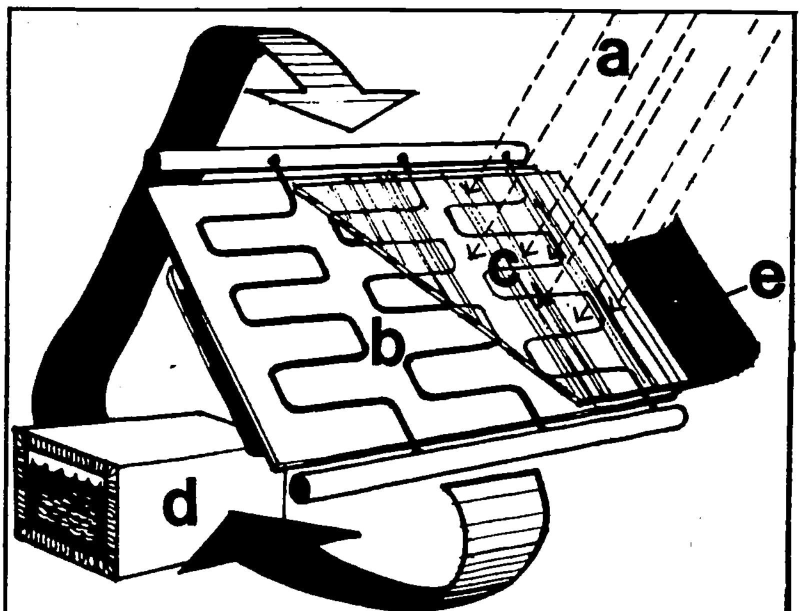

FIGURE 9 Schematic of solar-power system for the Madeira School: (a) sunrays, (b) water coils, (c) glass cover, (d) storage tank, (e) conventional roof.

16 SCIENCE MUSEUM, RICHMOND, VIRGINIA

Edward C. Fordyce
Science Museum of Virginia
217 Governor Street
Richmond, Virginia 23219
807/770-4133

The energy-conserving design developed for the Physical Sciences Center of the Science Museum of Virginia will include the use of solar heating and cooling. The 55,600-square-foot multi-level building for laboratories, shops, offices, a planetarium, and an auditorium will feature an extremely large (112 feet by 240 feet) 30-degree-sloping roof that will be covered with water/glycol-cooled flat-plate collectors. Three 50,000-gallon below-grade storage tanks--one each for high-temperature, low-temperature, and chilled fluids--will be used. An absorption unit powered by solar collectors, or stored chilled water, will supplement primary cooling provided by a conventional 150-ton air conditioner.

The building will incorporate other energy-conserving features including extensive waste heat recovery, variable volume ventilation, and recirculation of filtered and heated air to reduce fresh air needs. Recovered energy is expected to supply about 50 percent of the heating and 40 percent of the cooling requirements. Completion of the building is anticipated in fall 1976.

Other participants include Richard P. Hankins, Hankins & Anderson, Inc., Consulting Engineers, Richmond, Virginia, and James M. Glove, Glove, Newman, Anderson & Associatees, Inc., Architects and Engineers, Richmond, Virginia.

17 SOLAR COLLECTOR FENCE, COLORADO SPRINGS, COLORADO

Byron Bloomfield
Design Plus
1709 Woodmoor Drive
Monument, Colorado 80132
303/481-3656

An existing 2,000-square-foot house is being retrofitted with a solar collector consisting of vertical-mounted rectangular panels used also as a yard fence. Using 240 square feet of fence-style water/glycol-cooled flat-plate collectors in ten 4-foot-by-6-foot modules with adjacent aluminum reflector panels for additional solar radiation pickup, the system is designed for application to existing residences. Additional collector panels can be added as needed and the fence styling permits environment-enhancing use. Two 1,000-gallon below-grade tanks provide thermal storage. The retrofit demonstration is expected to be completed in 1974.

Other participants include James Sinton, the owner of the house.

18 SOLARCON CENTER, LOS ANGELES, CALIFORNIA

D.D. Beckhart
Harrison, Beckhart & Mill, Architects
844 W. Colorado Boulevard
Los Angeles, California 90041
213/254-7141

While still in the conceptual design stage, the first unit of a three-unit 770,000-square-foot complex will be a 300,000-square-foot office/condominium building. Solar-energy collectors, to be used for daytime absorption of solar energy for heating and nighttime radiant loss of heat for cooling, will be mounted on the vertical exterior building walls and "heat pipes" will be used to transfer heat energy from warmer areas of the building to cooler areas as needed.

19 SUN HOUSE, CLEVELAND, OHIO

Bob Schmitt
Bob Schmitt Homes, Inc.
13079 Falling Water
Strongville, Ohio 44136
216/238-6915

This 3,600-square-foot single-family residence is designed to provide optimum heat-loss-and-gain reduction through improved thermal and solar-energy control. The house features a 1,100-square-foot central atrium with skylights. Surrounding living areas use glass in walls facing to the atrium to allow heat collected and stored in atrium to be reradiated into living areas during cold weather. During warm weather the skylights are shaded and living areas lose heat via naturally induced ventilation through the atrium. Exterior walls are void of glass and additional insulation is used throughout. Air infiltration through window and door cracks is minimized and attic temperatures are controlled by a fan and louvers. An electric heat pump supplies supplementary heating and cooling. The demonstration house has been completed and evaluated and additional houses are being developed for sale.

Other participants include Edward A. Schmitt, Architect, Strongville, Ohio.

20 TEST HOUSE, COLORADO SPRINGS, COLORADO

Rod Kuharich
Phoenix of Colorado Springs, Inc.
P.O. Box 7246
Colorado Springs, Colorado 80914
303/633-2633

With a Study and Evaluation Grant from RANN-NSF this public nonprofit corporation test house has been built to demonstrate feasibility of solar energy heating and conservation design. The 3-bedroom, 2,190-square-foot house features 810 square feet of roof-mounted flat-plate solar collectors arranged in two longitudinal banks sloping at 55 degrees and separate by a reflecting surface on the roof. Dowtherm "J" is the transfer fluid used and supplementary heating and cooling is provided by a utility-powered heat pump. An 8,000-gallon below-grade tank offers an 8-day storage capacity and also receives waste heat from the refrigerator and freezer.

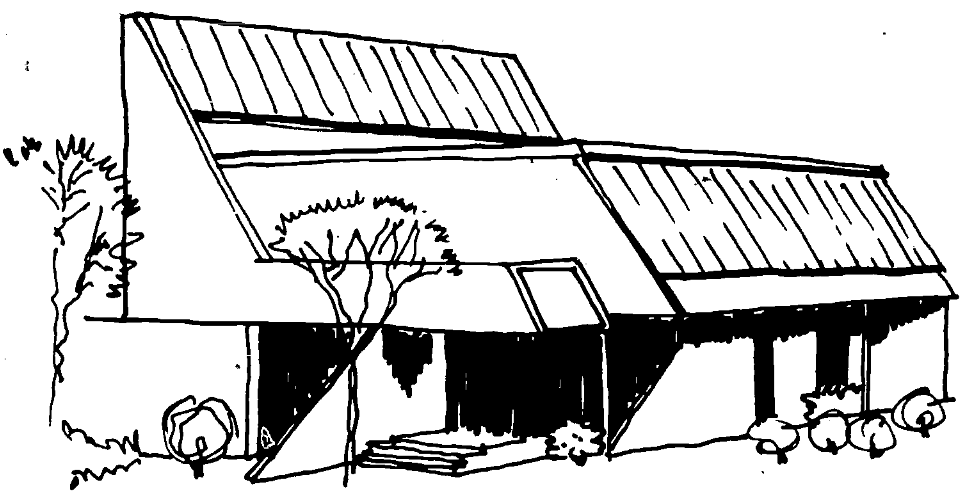

FIGURE 10 Phoenix solar house.

The house, located at 5925 Del Paz Drive in Colorado Springs, is designed to sell at from $35,000 to $40,000 exclusive of the solar system which is estimated to cost $15,000. Construction was completed in 1974 and the house will be occupied by a typical family in January 1975. Evaluation tests will be conducted from July 1975 to June 1976.

Other participants include Michael Lane, Charles Englund, and John Wheeler, the Design Group of Colorado, Colorado Springs, and Douglas Jardine, Mechanical Engineer, Denver, Colorado.

21 UNIVERSITY BUILDING, LAS CRUCES, NEW MEXICO

R.L. SanMartin
New Mexico State University
Las Cruces, New Mexico 88001
505/646-3007

This 19,000-square-foot building will house offices and laboratories of the university's Department of Agriculture and has been designed for energy conservation and solar-powered heating and cooling. Estimated to cost $1.5 million, the building will feature 7,000 square feet of roof-mounted, water/glycol-cooled solar collectors to provide 80 percent of heating and cooling requirements, two 30,000-gallon underground tanks to store enough energy for a 3-day period, and an Arkla absorption process unit for cooling. Construction is scheduled to begin in early 1975.

Other participants include Bridgers & Paxton, Mechanical Engineers, Albuquerque, New Mexico.

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