ORIGINAL

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM A DESCRIPTIVE SUMMARY OF HUD CYCLE 2 SOLAR RESIDENTIAL PROJECTS

FALL 1976

U.S. DEPARTMENT OF
HOUSING AND URBAN DEVELOPMENT
OFFICE OF POLICY DEVELOPMENT AND RESEARCH
Division of Energy, Building Technology and Standards
in cooperation with the Energy Research and Development Administration

preface

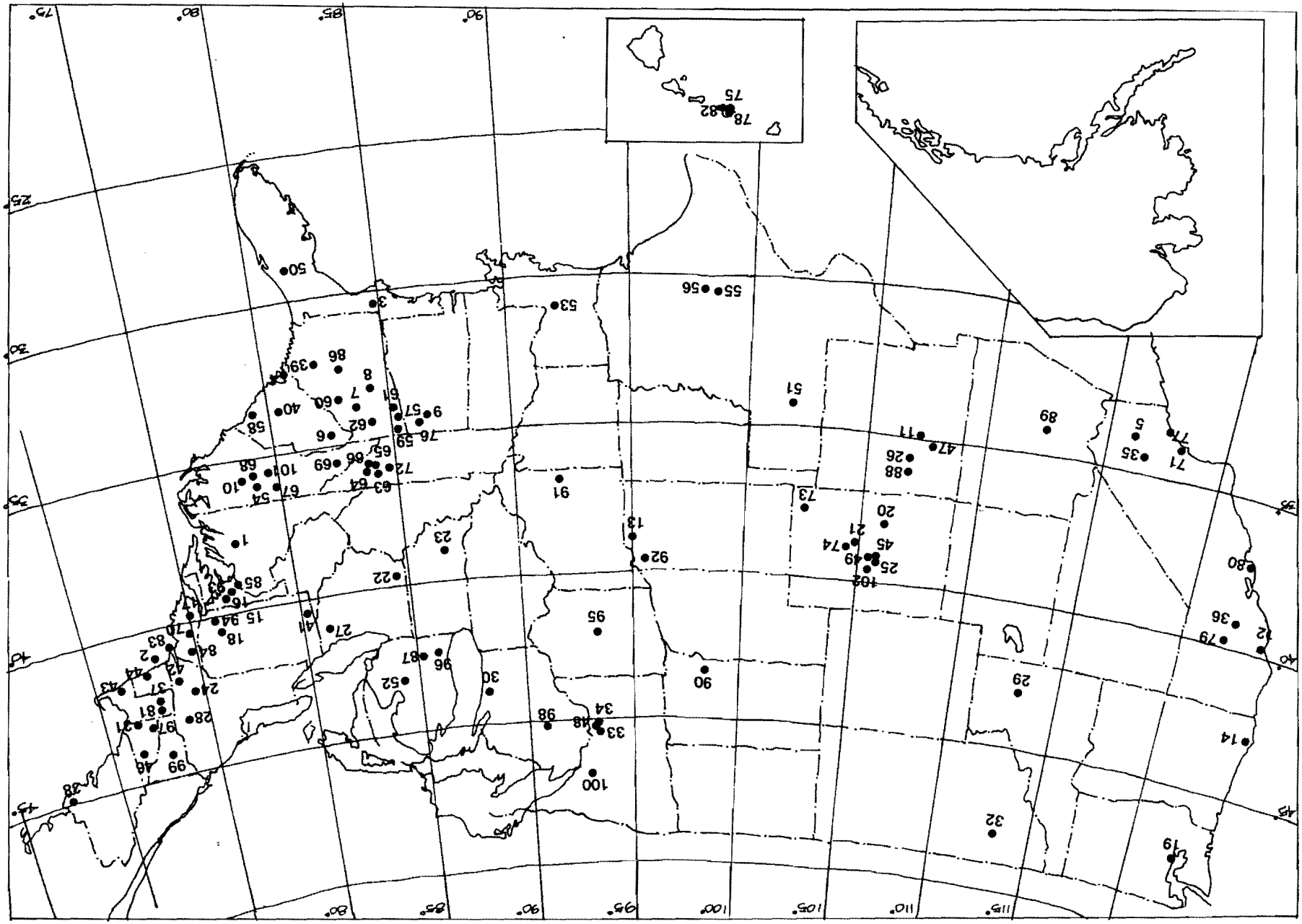
The award of nearly $4 million in grants to buy and install solar energy equipment in 1,411 residences was announced on October 15, 1976 by the Department of Housing and Urban Development. In a national effort to generate widespread use of solar energy, HUD is sponsoring five cycles of demonstration residential structures with solar heating and cooling systems.

The application forms for the HUD second cycle of solar residential demonstration projects were issued in July 1976, and over 300 applications were received in response to the invitation. A total of 348 single family dwellings and 1,063 multifamily units were selected.

Some projects may have been withdrawn or changed in this second demonstration program prior to the start of construction. However, in the interest of providing information on solar energy to the building industry and its customers, HUD has decided not to delay publication until all possible changes in the grants have taken place. Before visiting any project, we recommend that you contact the project sponsor to determine its status.

This publication is designed to provide the public with a general look at the selected projects. Each project summary identifies the grantee, and the location and size of the project, supplies a drawing of the unit, and describes the solar energy system.

We hope that this publication will help in developing information on systems and market practices that will further encourage the use of solar energy equipment, and will add to the public's awareness of solar energy as an alternative energy source.



list of projects

System	System	No. & Type	New/	DD/	Project Location

List of projects

Project No.	Builder/ Applicant	System Type	System Function	No. & Type Dwelling	New/ Retrofit	DD/ YR	Project Location
1	J&J Construction Co.	Active	H	1 SFD	New	4224	Dumfries, VA
2	Pinewood Manor Inc.	Active	H	1 SFD	New	4612	Long Island, NY
3	Town Council, City of Gretna	Active	HW	16 SFD	New	1485	Gretna, FL
4	Solar Development Assoc.	Active	HW	2 SFD	New	1973	Hilton Head Island, SC
5	Blue Skies Radiant Homes	Active	HW	16 SFD	New	2100	Hemet, CA
6	Heliothermics Inc.	Active	HW	6 SFD	New	2884	Greenville, SC
7	Fairview Builders	Active	HW	3 SFD	New	2961	Lawrenceville, GA
8	F.E. Fortenberry & Sons, Inc.	Active	HW	6 SFD	New	3018	Clarkston, GA
9	Chester West Inc.	Active	HW	1 SFD	New	3070	Huntsville, AL
10	Ecological Builders Inc.	Active	HW	1 SFD	New	3514	Raleigh, NC
11	Homes by Marilynn	Active	HW	2 SFD	New	4348	Albuquerque, NM
12	Mendocino Coast Properties	Active	HW	1 SFD	New	4424	Manchester, CA
13	Du-Mac Investment Co.	Active	HW	1 SFD	New	4711	Stillwell, KS
14	Twin City Builders Inc.	Active	HW	1 SFD	New	4726	Coos Bay, OR
15	Development Technology Inc.	Active	HW	2 SFD	New	4729	Columbia, MD
16	Evans, J.D.	Active	HW	4 SFD	New	4729	Columbia, MD
17	Joseph Barnes & Sons Inc.	Active	HW	1 SFD	New	4980	Cherry Hill, NJ
18	Gigliotti Corp.	Active	HW	1 SFD	New	5001	Northampton Twp., PA
19	Washington Natural Gas Company	Active	HW	1 SFD	New	5145	Seattle, WA
20	David L. Vickerman Inc.	Active	HW	1 SFD	New	5505	Evergreen, CO
21	Perl-Mack Enterprises Inc.	Active	HW	25 SFD	New	5505	Denver, CO
22	Lucke & Strassel Builders	Active	HW	1 SFD	New	5647	Butler, OH
23	Moulder Corp.	Active	HW	1 SFD	New	5669	Greenwood, IN
24	Suntech Homes, Inc.	Active	HW	1 SFD	New	5785	Chester, NY
25	Bell, Ervin J.	Active	HW	1 SFD	New	6283	Boulder, CO
26	Stanley Associates	Active	HW	1 SFD	New	6350	Santa Fe, NM
27	Homes by Stan-Jim Inc.	Active	HW	4 SFD	New	6417	Hubbard/Others, OH
28	Stewart-Teele-Mitchel Construction	Active	HW	1 SFD	New	6875	Malta, NY
29	Tas Development & Construction	Active	HW	1 SFD	New	7066	Pocatello, ID
30	Kuch, Theodore A.	Active	HW	1 SFD	New	7350	Lake Park Estate, WI
31	Fletcher Myers Inc.	Active	HW	1 SFD	New	7612	East Derry, NH
32	Design Construction Assoc.	Active	HW	1 SFD	New	8191	Bigfork, MT
33	Houston Construction Inc.	Active	HW	1 SFD	New	8382	Eden Prairie, MN
34	Gridley Construction Co.	Active	HW	1 SFD	New	8382	Minneapolis, MN
35	San Bernadino Comm. Dev. Co.	Active	HW	10 SFD	Retrofit	2018	San Bernadino, CA
	CA. Energy Conserv. & Dev. Comm.	Active	HW	1 SFD	Retrofit	4251	Sonoma Coast, CA
36	CA. Energy Conserv. & Dev. Comm.	Active	HW	1 SFD	Retrofit	4814	Prairie Creek, CA
	CA. Energy Conserv. & Dev. Comm.	Active	HW	1 SFD	Retrofit	7920	Donner, CA

	Applicant	Type	Function	Dwelling	Retrofit	YR	Project Location
37	Exec. Office of Community Dev.	Active	HW	1 SFD	Retrofit	6400	Northampton, MA
38	Pleasant Point Housing Authority	Active	HW	2 SFD	Retrofit	7344	Perry, ME
39	Unified Development Inc.	Active	HW	3 SFA	New	2200	Swainsboro, GA
40	Philips, Kauric, Adams & Branham	Active	HW	12 SFA	New	2484	St. Matthews, SC
41	Contemp. Import & Export Co.	Active	HW	4 SFA	New	5053	Pittsburgh, PA
42	D.W.S. Holdings Inc.	Active	HW	6 SFA	New	5219	Bedford, NY
43	Town of Marion	Active	HW	12 SFA	New	5891	Marion, MA
44	J. Capone Construction Co.	Active	HW	10 SFA	New	5897	Cheshire, CT
45	Wonderland Hill Development Co.	Active	HW	35 SFA	New	6103	Boulder, CO
46	Kearsarge Building Co. Inc.	Active	HW	5 SFA	New	7383	North Conway, NH
47	Albuquerque Western Solar Indus.	Active	HW	101 MF Mid	New	4383	Albuquerque, NM
48	Creek Associates	Active	HW	77 MF Mid	New	8382	Minneapolis, MN
49	Univ. of Colorado	Active	HW	95 MF Mid	Retrofit	6283	Boulder, CO
50	Florida Gas Co.	Active	HCW	1 SFD	New	766	Winter Springs, FL
51	Gordon Deering	Active	HCW	1 SFD	New	3578	Lubbock, TX
52	Durham Housing Authority	Active	HCW	18 SFA	New	3393	Durham, NC
53	City of Flint/Dept. of Comm. Dev.	Active	HCW	6 SFA	New	7377	Flint, MI
54	Baton Rouge Housing Authority	Active	HCW	2 SFA	Retrofit	1670	Baton Rouge, LA
55	Univ. of Texas, Austin	Active	HCW	12 MF Low	Retrofit	1711	Austin, TX
56	College Houses	Active	HCW	80 MF Low	Retrofit	1711	Austin, TX
57	Dalton Housing Authority	Active	W	12 SFA	New	3254	Dalton, GA
58	Miles & Teal Builders	Active	W	1 SFD	New	2484	Myrtle Beach, SC
59	Contemporary Homes Inc.	Active	W	1 SFD	New	3254	Cohutta, GA
60	Wilbanks, Lamar	Active	W	1 SFD	New	3254	Commerce, GA
61	Owens & Park Inc.	Active	W	1 SFD	New	3254	Dalton, GA
62	Brown, Wilburn Inc.	Active	W	2 SFD	New	3254	Ringgold, GA
63	Redman, Lynn	Active	W	2 SFD	New	3254	Knoxville, TN
64	Ramsdes, Richard	Active	W	1 SFD	New	3254	Knoxville, TN
65	Dossett, D. K.	Active	W	5 SFD	New	3254	Knoxville, TN
66	Architectural Developers Inc.	Active	W	5 SFD	New	3254	Knoxville, TN
67	GLS Construction Co.	Active	W	5 SFD	New	3805	Winston-Salem, NC
68	Robuck, Frank Jr.	Active	W	1 SFD	New	3805	Cary, NC

Project No.	Builder/ Applicant	System Type	System Function	No. & Type Dwelling	New/ Retrofit	DD/ YR	Project Location
69	Thomson & Associates	Active	W	3 SFD	New	4042	Asheville, NC
70	CA. Energy Conserv. & Dev. Comm.	Active	W	1 SFD	Retrofit	1300	San Diego, CA
	CA. Energy Conserv. & Dev. Comm.	Active	W	1 SFD	Retrofit	1525	Los Angeles, CA
71	R. H. Sinclair Const. Co., Inc.	Active	W	1 SFD	Retrofit	3254	Knoxville, TN
72	Colorado Rural Housing Dev. Corp.	Active	W	18 SFD	Retrofit	5402	Granada, CO
73	Finance Realty Co. Ltd.	Active	W	5 SFA	New	0	Ewa Beach, HI
74	Housing Development Co.	Active	W	5 SFA	New	3254	Madison, AL
75	Raritan Valley Comm. Dev. Fndn.	Active	W	8 SFA	New	4980	S. Brunswick Twp., NJ
76	Brothers Redevelopment Inc.	Active	W	2 SFA	Retrofit	5505	Denver, CO
77	Facilities Development Co.	Active	W	31 MF Low	New	1507	San Diego, CA
78	Hawaii Housing Authority	Active	W	19 MF Low	Retrofit	0	Waipahu, HI
79	Corbett, Michael N.	Active	W	10 MF Low	Retrofit	2819	Davis, CA
80	Colorado Park Housing Corp.	Active	W	60 MF Low	Retrofit	2969	Palo Alto, CA
81	Greenfield Housing Authority	Active	W	16 MF Low	Retrofit	5715	Greenfield, MA
82	Hei Wei Wong	Active	W	55 MF Mid	New	0	Honolulu, HI
83	Peoples Development Corp.	Active	W	28 MF Mid	Retrofit	4811	Bronx, NY
84	Dover Housing Authority	Active	W	61 MF Mid	Retrofit	4980	Dover, NJ
85	Forest City Dillon Inc.	Active	W	188 MF High	New	4600	Washington, DC
86	Kenilworth Manor Inc.	Active	W	80 MF High	Retrofit	2136	Macon, GA
87	Battle Creek Housing Comm.	Active	W	150 MF High	Retrofit	6778	Battle Creek, MI
88	Communico	Passive	HW	1 SFD	New	5586	Santa Fe, NM
89	S. Central Comm. Action Program Inc.	Passive	HW	4 SFA	New	7133	Lake Andes, SD
90	Kauffman, Herbert L.	Hybrid	HW	5 SFA	New	3324	Mayer, AZ
91	Wren, Oscar P. Jr.	Hybrid	HW	1 SFD	New	4561	Tomaro Oaks, MO
92	Byram, John C.	Hybrid	HW	1 SFD	New	4711	Shawnee, KS
93	THS, Inc.	Hybrid	HW	1 SFD	New	4760	Columbia, MD
94	Felton, William	Hybrid	HW	1 SFD	New	5101	Penn Valley, PA
95	Spence-Urban & Associates	Hybrid	HW	2 SFD	New	6808	West Des Moines, IA
96	Lion Enterprises	Hybrid	HW	1 SFD	New	6894	Almena Twp., MI
97	Total Environmental Action, Inc.	Hybrid	HW	1 SFD	New	7643	Harrisville, NH
98	Burdick, William C.	Hybrid	HW	1 SFD	New	8382	Rice Lake, WI
99	Greenmoss Builders Co.	Hybrid	HW	1 SFD	New	7876	Waitsfield, VT
100	Red Barn Realty Inc.	Hybrid	HW	1 SFD	New	10000	Esko, MN
101	Mongeau, Beatrice	Hybrid	HW	3 SFA	New	3450	Pittsboro, NC
102	Naumann, Robert C.	Hybrid	HW	2 SFA	Retrofit	6283	Boulder, CO

introduction

The use of solar energy for residential heating, cooling and domestic water heating is rapidly emerging as a viable and cost effective alternative to our present energy resources. This is due not only to the growing cost of non-renewable fossil fuels and the availability of solar equipment, but also to increasing consumer acceptance and confidence in solar heating and cooling. The fact that the number and variety of locations of solar heated and cooled buildings has increased dramatically over the last several years has contributed significantly to this growing consumer confidence. No longer is solar energy simply an article in the paper or weekly magazine or a brief television commercial, it is a building that can be seen down the street or over in the next town. It is this exposure to the actual workings of a solar system that has increased understanding and built confidence.

People are beginning to think more about the climate in which they live, its influence on the amount of energy they need for heating in winter and cooling in summer, how their lifestyles as well as their houses influence energy use, and about what they can expect from solar energy in their location. This level of thinking has resulted in an increased interest in working with energy from the sun. Since the sun cannot be isolated from the other environmental forces affecting a building, the development of solar energy use demands an integrated approach to conditioning a building, by responding to all environmental forces: vegetation, topography, drainage, soils, microclimate. The sun, in combination with the environment, can produce a more natural and affordable heated and cooled environment for the changing future.

In response to these developments, the Solar Heating and Cooling Demonstration Act of 1974 authorized an extensive research, development and demonstration program of solar heating and cooling systems

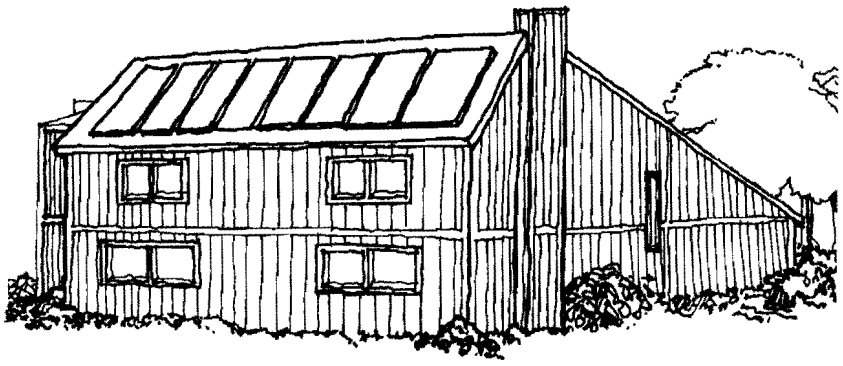
in buildings. As part of the ongoing national program, directed by the Energy Research & Development Administration, the residential demonstration program managed by HUD is designed to:

- finance solar systems in both new and existing dwellings
- develop performance criteria and test procedures for solar dwellings
- disseminate solar heating and cooling information
- undertake market development efforts to encourage the rapid and widespread acceptance of solar heating and cooling technologies by the housing industry throughout the U.S.

The present HUD Solar Demonstration Program is building upon earlier efforts to establish solar energy as a viable energy alternative and to encourage the use of solar energy by the designer, the builder, and the consumer in residential applications. The solar heated and/or cooled dwellings illustrated on the following pages represent the second series of projects selected under the HUD program. One important step for the development of these objectives is the distribution of information. Therefore this second publication describing the solar demonstration projects selected for HUD grants is being issued. The projects are organized by system type, building type, and degree day location, as listed in the list of projects. Within each project summary, three areas of concern are documented in order to provide a clear and concise understanding of the project. THE PROJECT INFORMATION section presents general background and climatic data. A brief discussion of the dwellings' energy conservation features, factors which improve the systems efficiency considerably, is found in the BUILDING DESCRIPTION/ENERGY CONCERNS section. The components and the relationships between components in the solar energy system are described in the final SOLAR ENERGY SYSTEM section.

A more specific glossary of terms applying to each section is found in the appendix along with maps of climatic design conditions.

project summaries

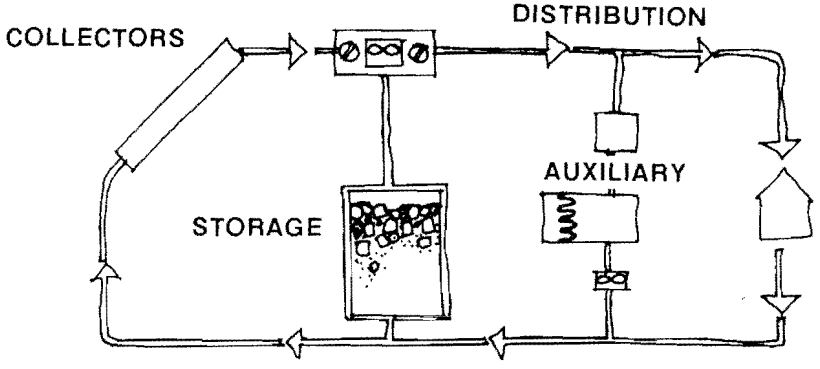


PROJECT INFORMATION

BUILDER/APPLICANT: J&J Construction Co.
DESIGNER: Westinghouse Electric Corp.
SOLAR SUB: Westinghouse Electric Corp.
LOCATION: Dumfries, VA
LATITUDE: 38.5°N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,632 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 4,224
COOLING HRS:
DESIGN TEMP: WINTER: 16° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 720 BTU/ft²
% SUN/YR: 58%

BUILDING DESCRIPTION/ENERGY CONCERNS

This new single family detached unit incorporates 1,632 sq. ft. with 3 bedrooms. Energy conservation features include minimal windows on the east and west elevations; double insulating glass in windows on the northern face and a garage located on the northwest corner to act as a thermal buffer. In addition, 3" of rigid insulation under a sheathing of blanket insulation is used in the walls and ceiling. Exterior doors are steel with integral weatherstripping.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating
PREDICTED SOLAR CONTRIBUTION: 52%

COLLECTOR: 205 sq. ft. of Sunworks/Solector, flat plate air collectors are located on the roof of the building at a 60° tilt. The building is oriented so that panels face south and are mounted with standoff framing. A collector fan transfers heated air to rock storage.

STORAGE: 400 cu. ft. of rock acts as heat storage in a bin constructed from concrete block with 1" foam insulation.

DISTRIBUTION: Heated air is blown either from rock storage to the living space, or directly drawn from the collector to the living space.

AUXILIARY ENERGY SYSTEM: An electric heat pump, with a coil located in the air ducts, heats the air supply to the living space.

MODES OF OPERATION: Collector to house, collector to storage, storage to house, auxiliary to house.

VIRGINIA
4224 DD
1 SFD NEW
ACTIVE HEATING
1

NEW YORK

4612 DD

1 SFD NEW

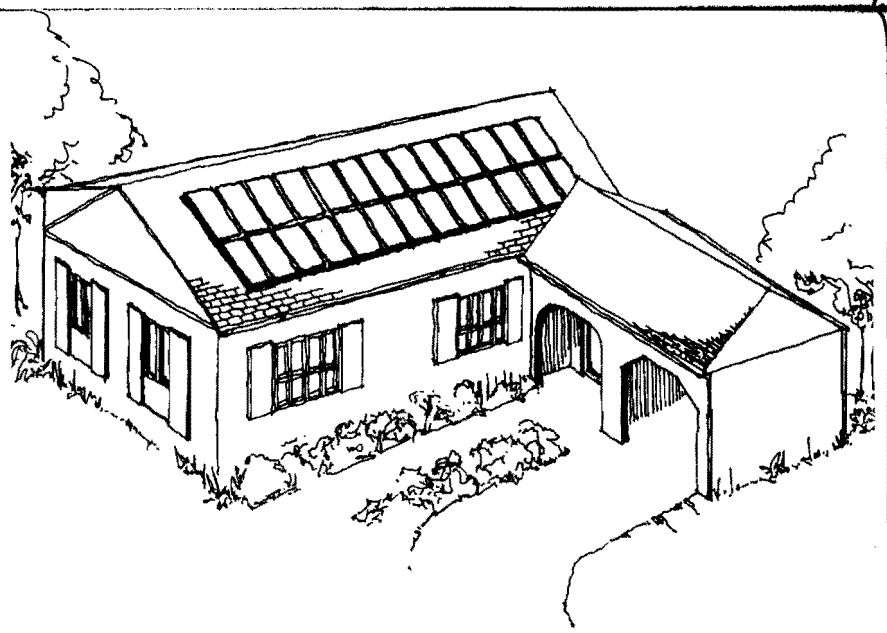
ACTIVE HEATING

2

BUILDER/APPLICANT: Pinewood Manor Inc.
DESIGNER: Siegmund Spiegel, AIA
SOLAR SUB: Sun Energy Power Ltd.
LOCATION: Long Island, NY
HOUSING TYPE: SFD, 1 Unit
CLIMATIC DATA:
HEATING DD: 4,612
DESIGN TEMP: WINTER: 0° F
HORIZ. INSOL. JAN. DAY: 500 BTU/ft²

LATITUDE: 41°N
AREA: 2,082 sq. ft.

COOLING HRS:
SUMMER:
% SUN/YR: 58%



BUILDING DESCRIPTION/ENERGY CONCERNS

This single family home encompasses 2,082 sq. ft. of floor area and 5 bedrooms.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating
PREDICTED SOLAR CONTRIBUTION: 64%

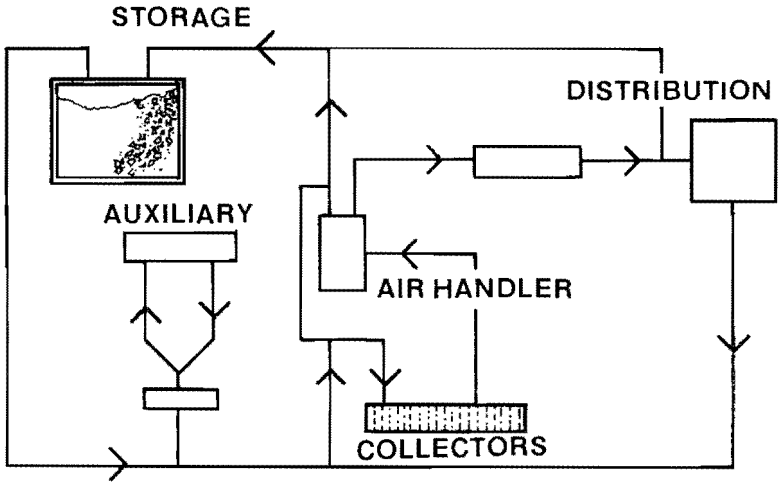
COLLECTOR: 257 sq. ft. of flat plate, vertical fin, air collector is located on the 10° south east facing roof at a 60° tilt. Manufactured by Sun Energy Power, Ltd., these collectors use air to transfer the sun's heat to rock storage.

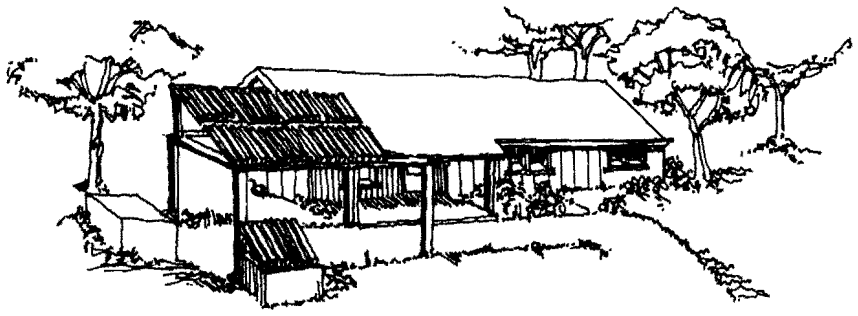
STORAGE: 200 cu. ft. of crushed rock is located in the basement. From here or directly from the collector, a central air handling unit blows air into the living space.

DISTRIBUTION: Forced air distributed by a central air handler (SAM).

AUXILIARY ENERGY SYSTEM: Supplied by an electric heat pump located outside the house, which can also act as a cooling assist, auxiliary energy capacity is 65,000 BTUH.

MODES OF OPERATION: Collector to house (via SAM), collector to storage (via SAM), storage to house, auxiliary to house, storage to auxiliary to house.

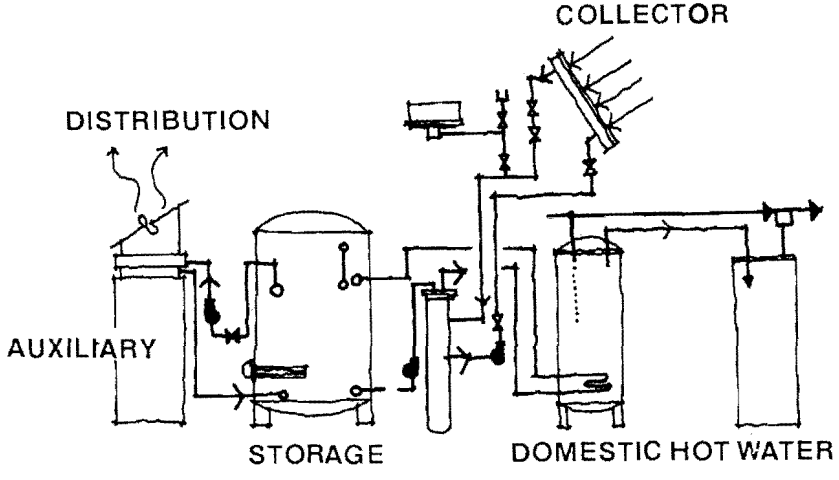




BUILDER/APPLICANT: Town Council-City of Gretna
DESIGNER: Florida A&M University
SOLAR SUB: General Electric Space Division
LOCATION: Gretna, FL
LATITUDE: 30°N
HOUSING TYPE: SFD, 16 Units
AREA: 864 sq. ft. each
CLIMATIC DATA:
HEATING DD: 1,485
COOLING HRS:
DESIGN TEMP: WINTER: 29° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 950 BTU/ft²
% SUN/YR: 62%

BUILDING DESCRIPTION/ENERGY CONCERNS

Sixteen units of 3 bedroom single family detached houses have been planned, with care taken to preserve deciduous trees where they would shade the house, but would not shade the collectors. Collectors have all been mounted on separate solar module buildings which enclose storage and supply pumps. These modules can be used as carports or garages and are located to suit sun conditions.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 80%

COLLECTOR: 148 sq. ft. of evacuated tube collectors are rack mounted at 40° tilt on the south facing roof of a solar module unit. Manufactured by General Electric, these collectors contain 2 concentric glass tubes around a copper absorber. An antifreeze ethylene glycol 30% solution is heated in the collectors and pumped to a central heat exchange (H.E.), transferring the heat to water for storage.
STORAGE: 500 gallons of water are stored in a steel cylindrical tank and insulated with 4" of batt insulation.
DISTRIBUTION: An air handling unit blows air over hot hydronic supply coils coming from storage.
AUXILIARY ENERGY SYSTEM: Provided first by an immersion electric heater located in storage, while total backup relies on a 27,000 BTUH electric boiler.
DOMESTIC HOT WATER: A second loop from the central heat exchanger takes water directly to another heat exchanger coil in a 66 gallon domestic hot water preheat tank. A conventional electric 52 gallon domestic hot water tank is located downstream.
MODES OF OPERATION: Collector to H.E. to storage, collector to H.E. to DHW to storage, storage to house.

4 ACTIVE HEATING & DHW 2 SFD NEW 1973 DD SOUTH CAROLINA

DESIGNER: Keane/Sherratt, Architects
SOLAR SUB: Wormser Scientific Corp.
LOCATION: Hilton Head, SC
LATITUDE: 32.1°N
HOUSING TYPE: SFD, 2 Units
AREA: 1,800, 2,600 sq. ft.
CLIMATIC DATA:
HEATING DD: 1,973
COOLING HRS:
DESIGN TEMP: WINTER: 29° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 933 BTU/ft²
% SUN/YR: 66%

BUILDING DESCRIPTION/ENERGY CONCERNS

Two single family units of three and four bedrooms respectively have been oriented 25° east of south and due south. Open to the south and southeast, the buildings have 6" batt insulation in the 2" x 6" construction, 12" above the ceiling, as well as 1½" thick perimeter insulation on foundation walls. Double glazing and thermal curtains, as well as large overhangs and sun screens have been added to prevent heat loss and heat gain. Attic ventilators and louvers aid summer cooling.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 71%, 70%

COLLECTOR: 252 sq. ft. and 292 sq. ft. respectively, of Sunworks' flat plate liquid collectors are mounted directly on the southern roof slope at a 37° tilt (favoring DHW heating). Water is pumped through the collector in an open loop to water storage. At temperatures below 37° F, the system drains down to storage.

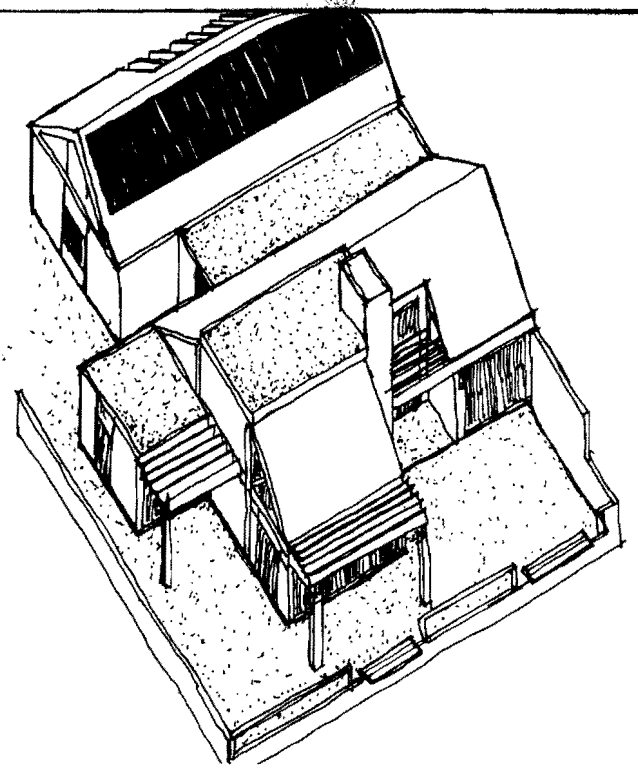
STORAGE: 1,000 gallons of water are located in an insulated cylindrical tank, on grade, near the kitchen.

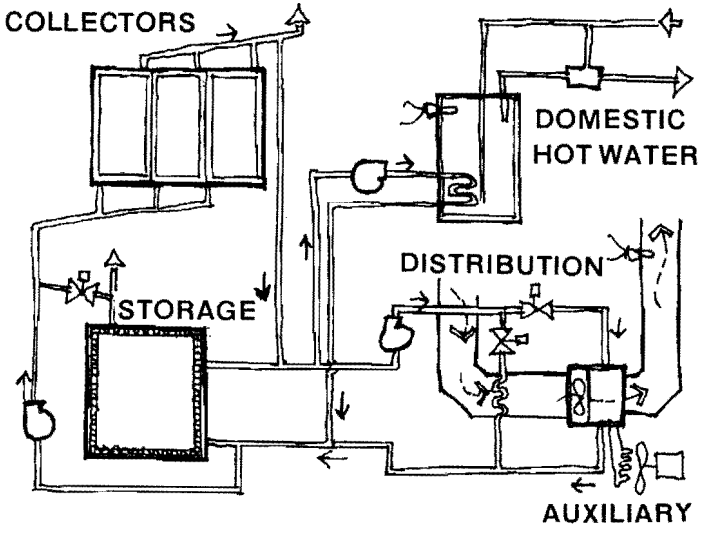
DISTRIBUTION: The solar heated water is pumped through a coil in the air handling unit which transfers the heat for forced hot air distribution.

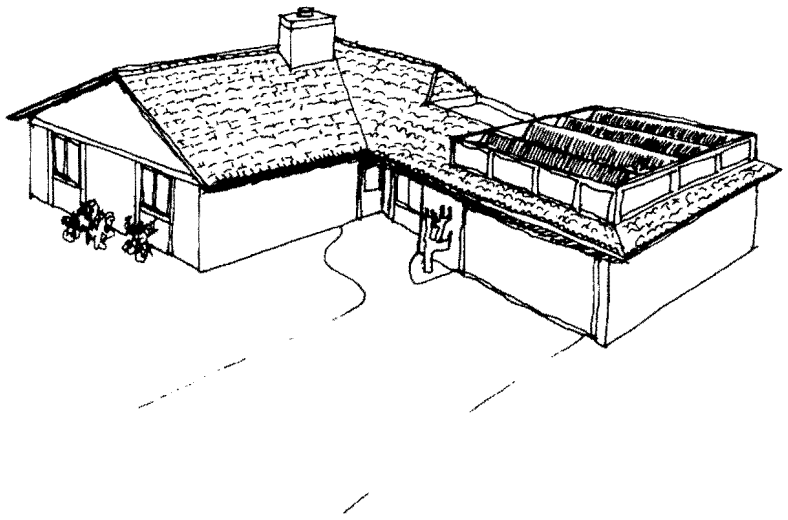
AUXILIARY ENERGY SYSTEM: A water-to-air electric heat pump with 42,000 BTUH or 66,000 BTUH capacity acts as the auxiliary system for both buildings, assisting both heating and cooling loads. Electric resistance, air-duct heaters at 25,000 BTUH and 30,000 BTUH serve as system backups.

DOMESTIC HOT WATER: A single copper coil located in solar storage preheats the city water supply, before it enters a 120 gallon storage tank with an electric coil at the top to provide additional heat when required.

MODES OF OPERATION: Collector to house (via air handler), collector to storage, storage to house, auxiliary to house, storage to auxiliary to house, DHW preheat.







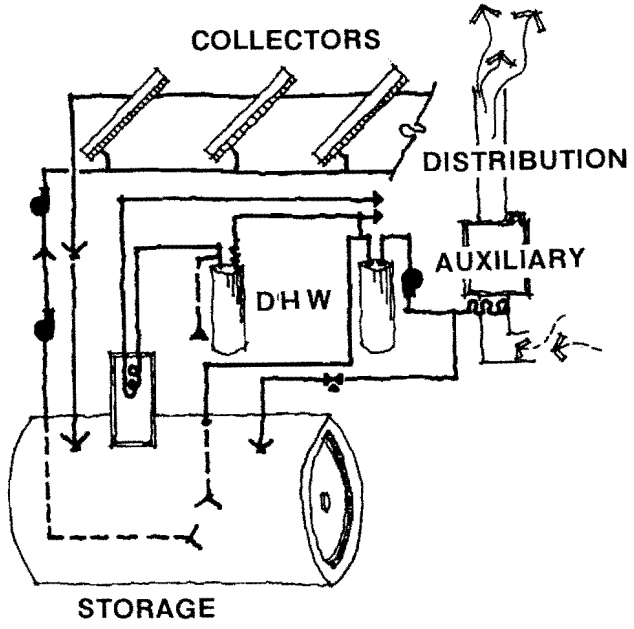
BUILDER/APPLICANT: Blue Skies Radiant Homes
DESIGNER: Warren D. Buckmaster
SOLAR SUB: Warren D. Buckmaster
LOCATION: Hemet, CA
HOUSING TYPE: SFD, 16 Units
CLIMATIC DATA:
HEATING DD: 2,100
DESIGN TEMP: WINTER: 43° F
HORIZ. INSOL. JAN. DAY: 935 BTU/ft²

LATITUDE: 33°N
AREA: 1,000-1,500 sq. ft.

COOLING HRS:
SUMMER:
% SUN/YR: 78%

BUILDING DESCRIPTION/ENERGY CONCERNS

16 single family detached houses are being built in 2, 3, and 4 bedroom models. Energy conservation features include increasing ceiling insulation to R-27 and adding a polyethylene vapor barrier. Double thermal glazing and weatherstripping reduce heat loss, while increased roof overhangs shield windows from sun effects. Other considerations include using fireplaces as auxiliary heat sources and fluorescent lighting to minimize electricty use.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 88.5%

COLLECTOR: 170 sq. ft., 204 sq. ft., and 238 sq. ft. of Revere flat plate collectors have been located on a flat portion of the roofs, on a rack oriented south and tilted at a 43° angle. Water is pumped from storage, warmed (if freezing is a threat), and heated in the collectors before returning to storage.

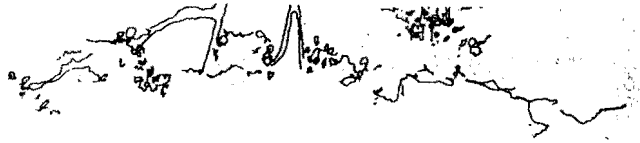
STORAGE: 1,000 gallons of water storage is located in a concrete storage tank wrapped in 5" of rigid insulation.

DISTRIBUTION: Fan coil heat exchangers are located in the air ducts transferring solar heat to air for the forced hot air distribution system.

AUXILIARY ENERGY SYSTEM: A conventional gas-fired forced air furnace, and a conventional 40 gallon water heater, supply all auxiliary heat to the ducts as needed.

DOMESTIC HOT WATER: City water supply is pre-heated in a fluid tube heat exchanger above storage, with conductors extending into storage, on its way to a conventional 40 gallon gas-fired water tank. A second storage assisted conventional water heater acts as backup for both DHW, and duct-heating coils.

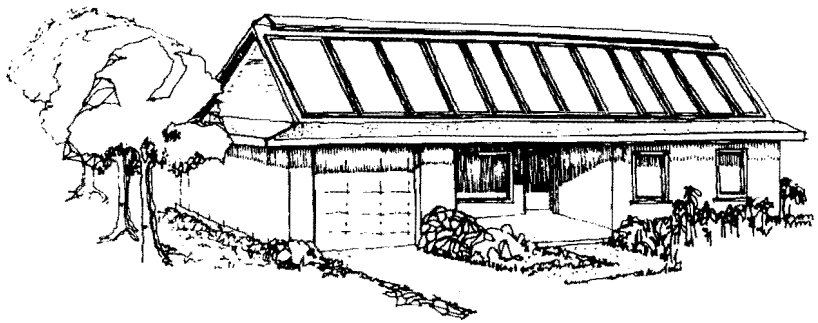
MODES OF OPERATION: Collector to storage, storage to house (via air handler), storage to auxiliary to house, auxiliary to house, DHW preheat.



BUILDER/APPLICANT: Fairview Builders
DESIGNER: Winford Lindsay, Arch.
SOLAR SUB: Independent Living, Inc.
LOCATION: Lawrenceville, GA
HOUSING TYPE: SFD, 3 Units
CLIMATIC DATA:
LATITUDE: 33.4°N
AREA: 1,000 sq. ft.

SOLAR SUB: Solar Energy Technology
LOCATION: Greenville, SC
HOUSING TYPE: SFD, 6 Units
CLIMATIC DATA:
HEATING DD: 2,884
DESIGN TEMP: WINTER: 23° F
HORIZ. INSOL. JAN. DAY: 800 BTU/ft²

LATITUDE: 34.5°N
AREA: 1,086 sq. ft.
COOLING HRS: 800
SUMMER: 95° F
% SUN/YR: 60%



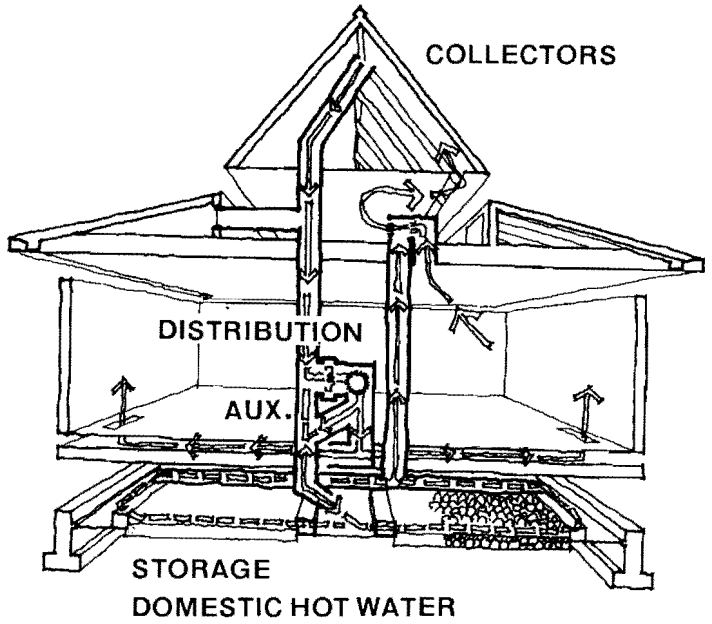
BUILDING DESCRIPTION/ENERGY CONCERNS

This single family detached home encompasses 1,086 sq. ft. of space and has 3 bedrooms. Energy conservation features include using the attic for winter heat collection and circulation, and for summer ventilation and cooling. The house is oriented on the east-west axis so that the southern face has maximum exposure, while overhangs on all faces shade against the summer sun. All windows are double glazed, the exterior walls have 5½" of insulation and the ceiling has 12" of insulation. Finally, berming is done to further insulate the house. Six of these units will be built.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 100%

COLLECTOR: 400 sq. ft. of cover plate is integrally mounted to the south facing roof at a 50° tilt. Manufactured on the site, this cover allows attic air to become heated and transfer the sun's heat to rock storage.
STORAGE: 836 cu. ft. of rock is located in a 12" deep bed in the crawl space below the house, with 1" of polystyrene insulation. From storage or directly from the collector, air is blown over an auxiliary heat exchange coil to baseboard units.
DISTRIBUTION: Forced hot air.
AUXILIARY ENERGY SYSTEM: Supplied by gas-fired hot water heat exchange coils located in the central ductwork of the house; the capacity of this source is 34,986 BTU/hr.
DOMESTIC HOT WATER: City water is preheated in an aluminum & copper paddle in the attic floor, before being circulated to an electric preheat tank and then to an 80 gallon conventional gas fired hot water heater.
COOLING: A passive cooling system; cool air is supplied from the rock storage and circulated through the house. Collectors work at night in summer to cool the rock bed. In addition, hot air is drawn from the space and out of the attic.
MODES OF OPERATION: Collector to house, collector to storage, storage to house, storage to auxiliary to house, DHW preheat, passive cooling.



PROJECT INFORMATION:

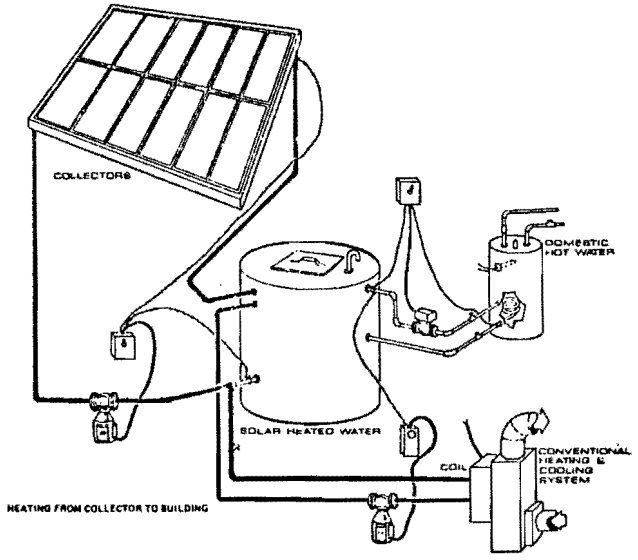
BUILDER/APPLICANT: Fairview Builders
DESIGNER: Winford Lindsay, Arch.
SOLAR SUB: Independent Living, Inc.
LOCATION: Lawrenceville, GA
HOUSING TYPE: SFD, 3 Units
CLIMATIC DATA:
HEATING DD: 2,961
DESIGN TEMP: WINTER: 20° F
HORIZ. INSOL. JAN. DAY: 806 BTU/ft²

LATITUDE: 33.4°N
AREA: 1,000 sq. ft.

COOLING HRS:
SUMMER:
% SUN/YR: 60%

BUILDING DESCRIPTION/ENERGY CONCERNS

This project involves 3 new single family detached homes of 1,000 sq. ft. each, with different floor plans and price tags. One passive design concern includes overhangs on the south wall to reduce heat gain in summer.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 75.4%

COLLECTOR: 234 sq. ft. of flat plate collector, manufactured by Revere, is integrated with the structure on the roof of each unit. The tilt is 45° on the south facing roof slope. Water is used to transfer heat to liquid storage.

STORAGE: A 1,000 gallon steel water storage tank is located in the basement of the unit. The heated water is pumped from storage through a heat exchange coil in the air duct.

DISTRIBUTION: Forced air conventional system.

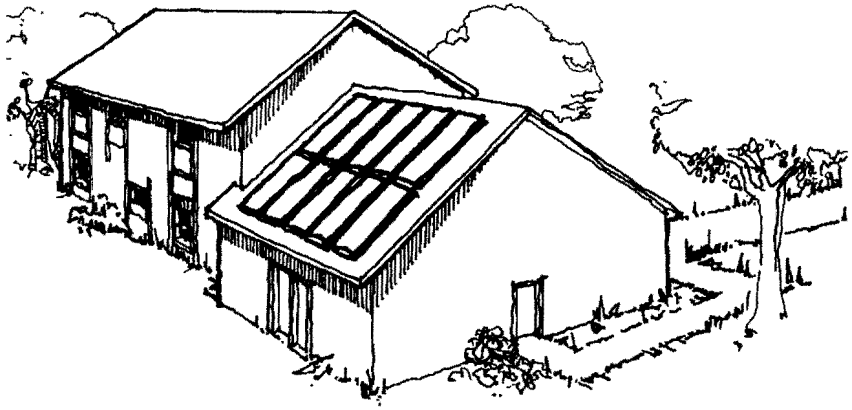
AUXILIARY ENERGY SYSTEM: A conventional gas-fired furnace with a capacity of 18,000 BTUH heats the air in the ducts as backup energy.

DOMESTIC HOT WATER: A closed loop from the storage tank channels hot water through a preheat coil in the conventional hot water heater.

MODES OF OPERATION: Collector to storage, storage to house, auxiliary to house, DHW preheat.

8 ACTIVE HEATING & DHW 6 SFD NEW 3018 DD GEORGIA

BUILDER/APPLICANT: F. E. Fortenberry & Sons, Inc.
DESIGNER: Fortenberry & Sons, Inc.
SOLAR SUB: Apollo Heating & Air Conditioning, Inc.
LOCATION: Clarkston, GA **LATITUDE:** 33°N
HOUSING TYPE: SFD, 6 Units **AREA:** 1,408,-2,051 sq. ft.
CLIMATIC DATA:
HEATING DD: 3,018 COOLING HRS: 1,630
DESIGN TEMP: WINTER: 18° F SUMMER: 92° F
HORIZ. INSOL. JAN. DAY: 806 BTU/ft² % SUN/YR: 52%

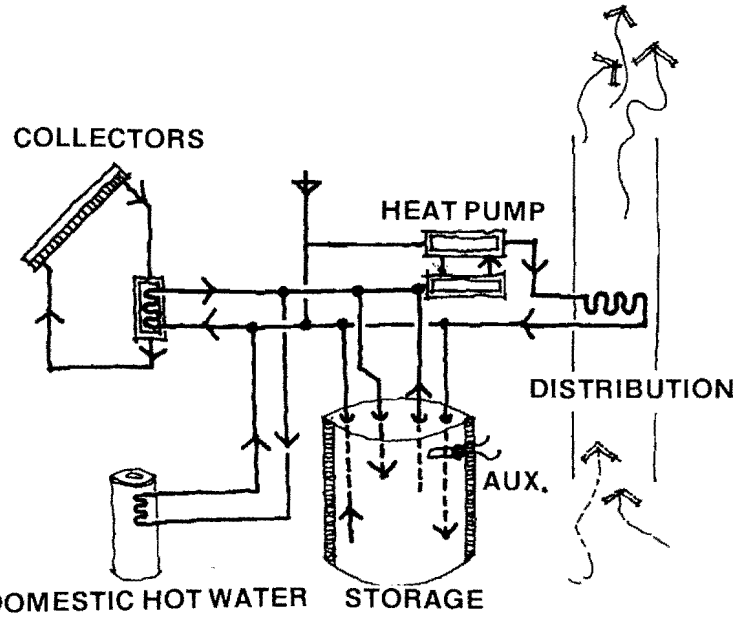


BUILDING DESCRIPTION/ENERGY CONCERNS

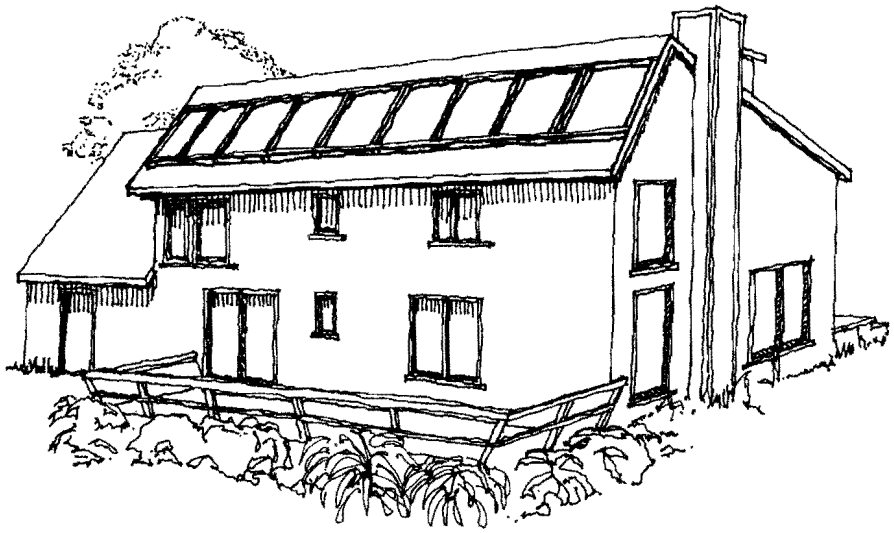
These six single family homes are of 3 different types, covering 1,408, 1,418, and 2,051 sq. ft. with 3 or 4 bedrooms. Energy conservation features include a major increase in insulation (ceiling insulation of 6" batt and 6" blown; perimeter insulation of 4" with a 1" moisture barrier in the foundations; 6" floor insulation and 5½" wall insulation. All windows are metal with double glazing and are caulked. There are no windows on the east or west face, with most windows facing south. In addition, there are roof vents for summer cooling.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating and Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 73.7% to 77.6%



COLLECTOR: 300 sq. ft., 450 sq. ft., and 460 sq. ft. respectively of flat plate trickle down, liquid collectors are located on the south facing roof at a 40°, 40°, 33° tilt, and are integrated into the roof structure. Manufactured by Scientific-Atlanta, these collectors use a silicone-DOW 200 antifreeze liquid to transfer the sun's heat, through a heat exchanger, to water storage.
STORAGE: 3,000 gallons of water are located underground in a concrete tank insulated with 4" of foam insulation.
DISTRIBUTION: Air is pre-heated over hydronic coils coming from water storage, then fan blown to the living space.
AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by an electric heat pump, with a direct coil in the air duct, as well as by an immersion resistance heater in storage. The heat pump can also act as a cooling assist. Auxiliary energy capacity is 27,320 BTUH.
DOMESTIC HOT WATER: Potable water is heated in the collector heat exchanger, and circulated back to the DHW tank.
COOLING: Heat pump assisted.
MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.



PROJECT INFORMATION:

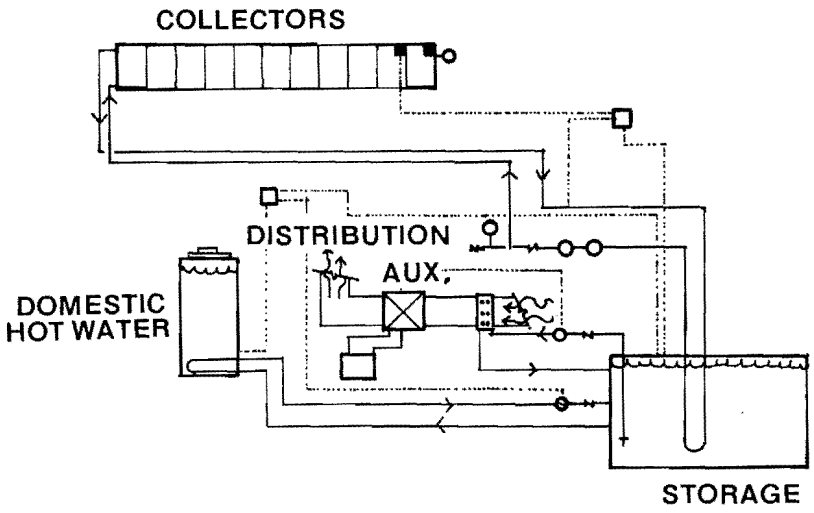
BUILDER/APPLICANT: Chester West Inc.
DESIGNER: Remtech, Inc.
SOLAR SUB: Daystar Corp.
LOCATION: Huntsville, AL
HOUSING TYPE: SFD, 1 Unit
CLIMATIC DATA:
HEATING DD: 3,070
DESIGN TEMP: WINTER: 13° F
HORIZ. INSOL. JAN. DAY: 738 BTU/ft²

LATITUDE: 34.4°N
AREA: 2,287 sq. ft.

COOLING HRS:
SUMMER: 95° F
% SUN/YR: 61%

BUILDING DESCRIPTION/ENERGY CONCERNS

This is a single family 3 bedroom dwelling of 2,287 sq. ft. Energy conserving features include a large roof on the north side which helps to lift cold winds over the building. Improved insulation is used and window surfaces are minimized to reduce heat loss. The garage placement on the west provides a buffer from late afternoon sun.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 45%

COLLECTOR: 208 sq. ft. of Daystar Corp. flat plate collector is mounted at a 49° angle on the south facing roof. A mixture of antifreeze and water transports collected heat to a heat exchanger in storage.

STORAGE: The heat exchanger transfers collected heat to water contained in a 480 gallon cylindrical insulated storage tank located underground. This heated water is pumped to a coil in the air duct of the distribution system.

DISTRIBUTION: Forced hot air.

AUXILIARY ENERGY SYSTEM: Auxiliary energy is provided by a combination of a heat pump and resistance heaters in the ducts, with a capacity of 28,000 BTUH.

DOMESTIC HOT WATER: A finned copper heat exchanger in the 80 gallon DHW tank provides DHW preheat from a storage loop.

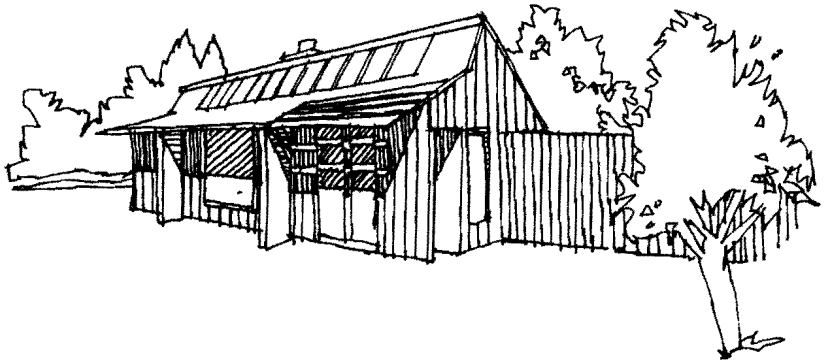
MODES OF OPERATION: Collector to storage, storage to house, auxiliary to house, storage to auxiliary to house, DHW preheat.

ACTIVE HEATING & DHW 1 SFD NEW 3514 DD NORTH CAROLINA

10

PROJECT INFORMATION:

BUILDER/APPLICANT: Ecological Builders Inc.
DESIGNER: Integrated Energy Systems
SOLAR SUB: Sunspot Solar Products, Inc.
LOCATION: Raleigh, NC
LATITUDE: 35°50'N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,376 sq. ft.
CLIMATIC DATA:
HEATING DD: 3,514
COOLING HRS: 1,050
DESIGN TEMP: WINTER: 20° F
SUMMER: 92° F
HORIZ. INSOL. JAN. DAY: 850 BTU/ft²
% SUN/YR: 61%

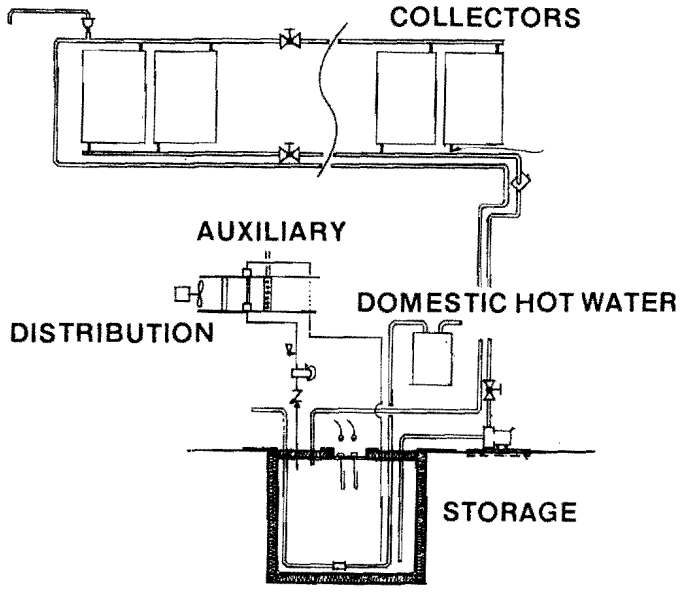


BUILDING DESCRIPTION/ENERGY CONCERNS

This single family home has 1,376 sq. ft. of floor space and 3 bedrooms. Energy conservation features include: the use of insulating glass in all windows; overhangs on west, south and east faces; with a loggia shading the east facing windows, and no windows on the northern face. Vines and trees provide extra shading. Windows on the south face are louvered for summer ventilation.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 68%



COLLECTOR: 206 sq. ft. of flat plate, double glazed, liquid collector is located on the south facing roof at a 50° tilt. Manufactured by Revere, these collectors are integrated into the roof structure. They use water with drain down to prevent freezing in the circuit. This liquid transfers the sun's heat to liquid storage.

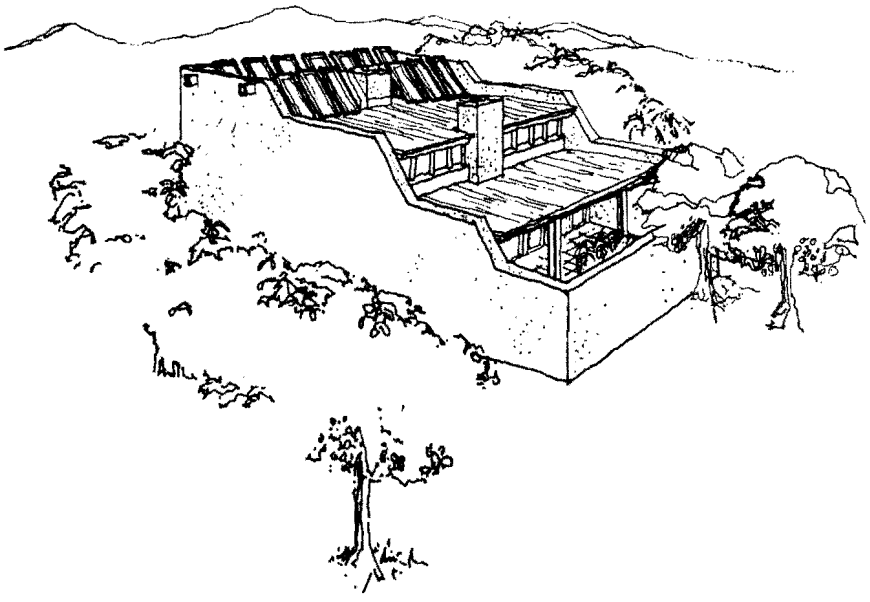
STORAGE: 1,300 gallons of liquid are located under the house in an insulated tank. The heated fluid is transported from the storage to fan coil units in the ducts.

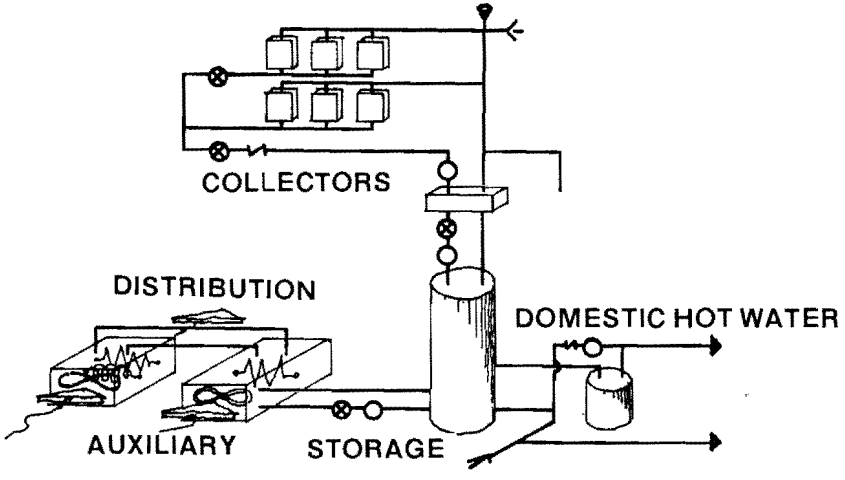
DISTRIBUTION: Forced hot air.

AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by a water to air heat pump, with a secondary backup supplied by two 4,500 watt electric elements immersed in the storage tank.

DOMESTIC HOT WATER: DHW is preheated by bringing the city water through a coil wrapped around solar heat storage.

MODES OF OPERATION: Collector to storage, storage to house, auxiliary to house, storage to auxiliary to house, DHW preheat.





PROJECT INFORMATION:

BUILDER/APPLICANT: Homes By Marilynn
DESIGNER: Don Schlegel, Arch.
SOLAR SUB: Southwest Sun Systems
LOCATION: Albuquerque, NM
LATITUDE: 35°N
HOUSING TYPE: SFD, 2 Units
AREA: 2,050 sq. ft.
CLIMATIC DATA:
HEATING DD: 4,348
COOLING HRS:
DESIGN TEMP: WINTER: 0° F
SUMMER: 100° F
HORIZ. INSOL. JAN. DAY: 1,120 BTU/ft²
% SUN/YR: 77%

BUILDING DESCRIPTION/ENERGY CONCERNS

These two new single family homes have three bedrooms and encompass 2,050 sq. ft. of floor area each. Energy conservation features include a compact plan to minimize heat loss and heat gain, aided by the use of massive exterior walls; no windows on the east and west sides; an entry organized to form a buffer zone for the interior space; and shading of windows on the south side, with a deep overhang to shield the house from summer heat gain.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 62%

COLLECTOR: 300 sq. ft. of flat plate Revere collector is located on the roof, facing south at a 55° tilt. A 50% water, 50% antifreeze mixture transfers the sun's heat to liquid storage.

STORAGE: A double heat exchanger transfers collected heat from the collector fluid to 1,000 gallons of underground water storage. Preheated water is then carried to a coil in the compressor unit of the auxiliary heat pump, over which air blows into the space.

DISTRIBUTION: Forced hot air.

AUXILIARY ENERGY SYSTEM: A conventional heat pump with 60,000 BTUH capacity provides heating and cooling assist for the forced air system.

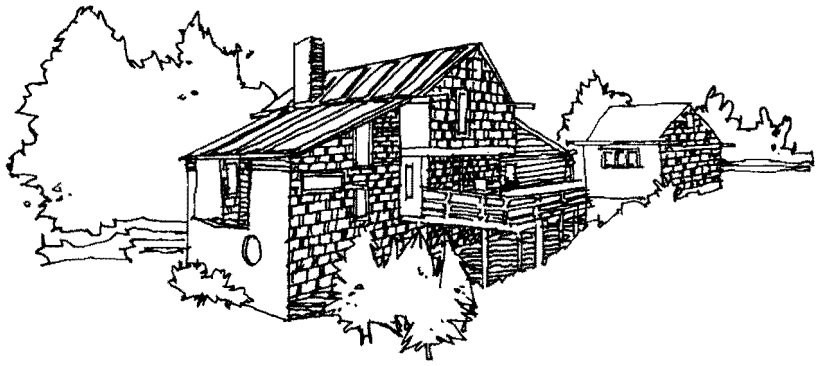
DOMESTIC HOT WATER: A coil in the solar storage tank supplies heat to water circulating from the auxiliary water tank.

MODES OF OPERATION: Collector to storage, storage to house (via heat pump), DHW preheat, auxiliary to house.

CALIFORNIA 4424 DD 1 SFD NEW ACTIVE HEATING & DHW

12

BUILDER/APPLICANT: *Mendicino Coast Properties*
DESIGNER: George Klett, Arch.
SOLAR SUB: Sunlight & Power Co.
LOCATION: Manchester, CA
LATITUDE: 39°40'N
HOUSING TYPE: SFD, 1 Unit
AREA: 2,172 sq. ft.
CLIMATIC DATA:
HEATING DD: 4,424
COOLING HRS:
DESIGN TEMP: WINTER: 34° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 555 BTU/ft²
% SUN/YR: 31%

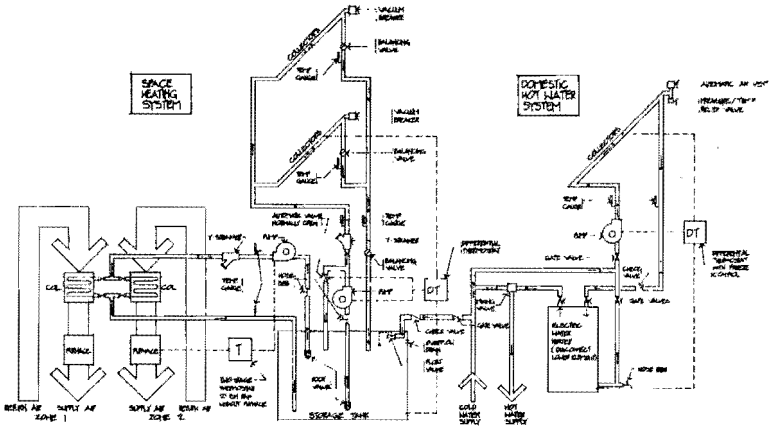


BUILDING DESCRIPTION/ENERGY CONCERNS

This is a new single family home with 3 bedrooms having 2,172 sq. ft. of floor area. Energy conservation features include extra insulation, no north facing windows and the use of the site slope to provide wind protection. A specially designed fireplace adds heat to the living space. Overhangs provide shading on the east and west elevations.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 79%



COLLECTOR: The roof mounted, sunlight & power flat plate collectors (a portion at 45°, a portion at 26°) provide 580 sq. ft. of collector area. Water transports the collected energy to water storage. Freeze protection is by the drain down method.

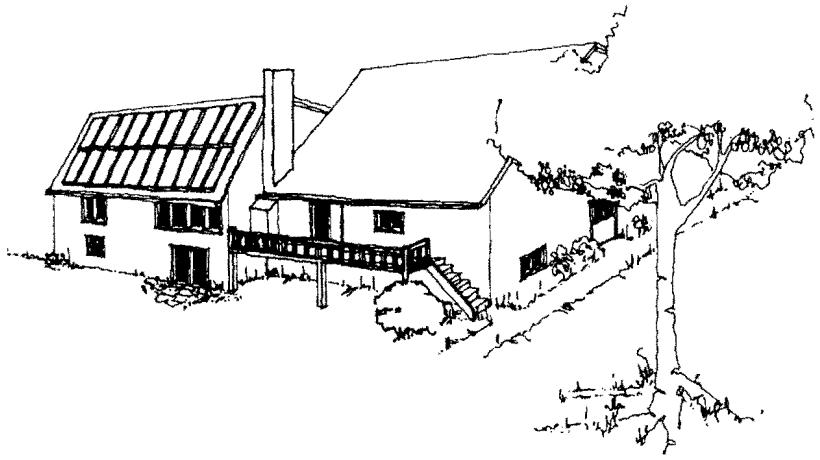
STORAGE: A 1,500 gallon pre-cast concrete tank, filled with solar heated water is located in the basement. The water is pumped through a coil in the return air duct to transport the heat to the living space.

DISTRIBUTION: Forced air.

AUXILIARY ENERGY SYSTEM: An electric furnace with a capacity of 36,000 BTUH is the auxiliary heating system.

DOMESTIC HOT WATER: Incoming city water is pumped through the collector at the 26° tilt, then to a 120 gallon conventional water tank.

MODES OF OPERATION: Collector to storage, storage to house (via heat exchanger coil), auxiliary to house, DHW preheat.

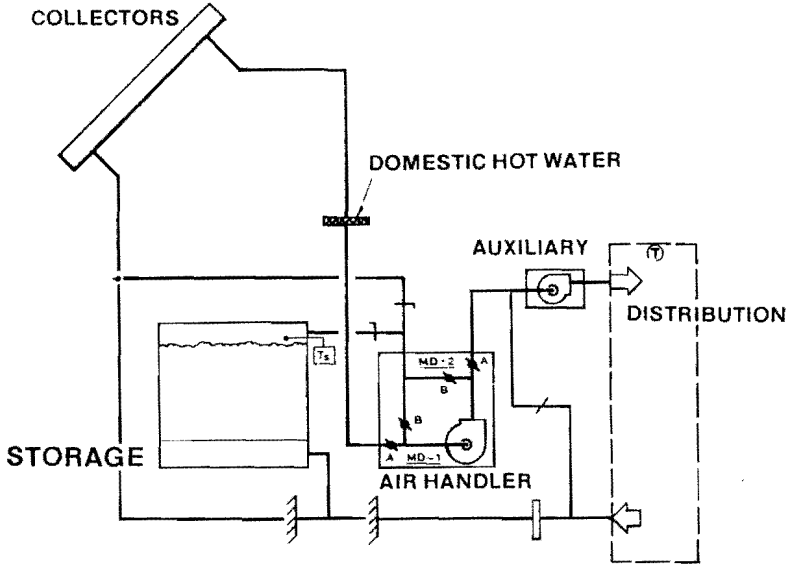


PROJECT INFORMATION:

BUILDER/APPLICANT: DU-MAC Investment Co.
DESIGNER: Elswood-Smith & Carlson A.I.A.
SOLAR SUB: Mid-America Solaron Co.
LOCATION: Stillwell, KS
LATITUDE: 39°N
HOUSING TYPE: SFD, 1 Unit
AREA: 2,260 sq. ft.
CLIMATIC DATA:
HEATING DD: 4,711
COOLING HRS:
DESING TEMP: WINTER: 8° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 720 BTU/ft²
% SUN/YR: 63%

BUILDING DESCRIPTION/ENERGY CONCERNS

This three bedroom two-story frame house incorporates 2,260 sq. ft. of floor area. In order to conserve energy, the building has been elongated facing south, minimizing west and east faces, and window area has been eliminated east and west. In addition, the land has been graded and filled, so that there is a smaller north face to prevent heat loss. Attic and ceiling vents have been added for summer ventilation.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 44%

COLLECTOR: 390 sq. ft. of Solaron flat plate air collectors have been directly mounted on a 10° west of south facing roof at a 52° tilt. Air is drawn through the collector and blown to a rock storage.

STORAGE: 360 cu. ft. of rock storage has been located in the basement in a concrete bin with 1½" of insulation.

DISTRIBUTION: A central air handling unit blows air across the rock storage for forced air distribution.

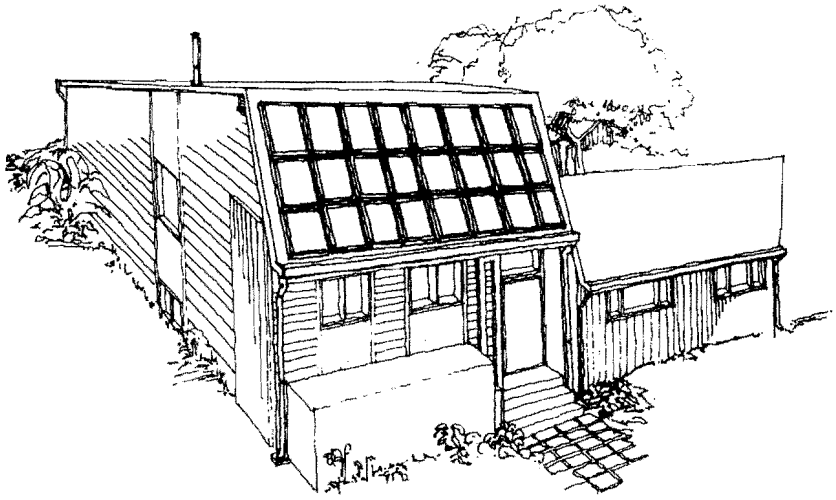
AUXILIARY ENERGY SYSTEM: An electric heat pump of 34,000 BTUH capacity supplies auxiliary and back-up energy.

DOMESTIC HOT WATER: Cold water supply passes through a fin-coil heat exchanger located in the collector to storage air duct. City water is preheated on its way to an 80 gallon conventional electric hot water heater.

MODES OF OPERATION: Collector to storage (via air handling unit), collector to house (via air handler), storage to house (via air handler), storage to auxiliary to house, auxiliary to house, DHW preheat.

KANSAS
4711 DD
1 SFD NEW
ACTIVE HEATING & DHW
13

BUILDER/APPLICANT: Twin City Builders, Inc.
DESIGNER: Krause, Fitch, Beals, Arch.
SOLAR SUB: Chambers Plumbing & Heating
LOCATION: Coos Bay, OR
LATITUDE: 43°N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,554 sq. ft.
CLIMATIC DATA:
HEATING DD: 4,726
COOLING HRS:
DESIGN TEMP: WINTER: 20° F
SUMMER: 90° F
HORIZ. INSOL. JAN. DAY: 569 BTU/ft²
% SUN/YR: 50%



BUILDING DESCRIPTION/ENERGY CONCERNS

This new single family home has 3 bedrooms and 1,554 sq. ft. of space. Window area is reduced to prevent heat loss. Overhangs on south face prevent summer heat gain.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 40.4%

COLLECTOR: The 234 sq. ft. of Revere flat plate collectors are located on the roof, facing due south at an angle of 60°. A 20% solution of anti-freeze and water is pumped through the collector to either a coil in the return air duct or to a heat exchanger which transfers heat to storage.

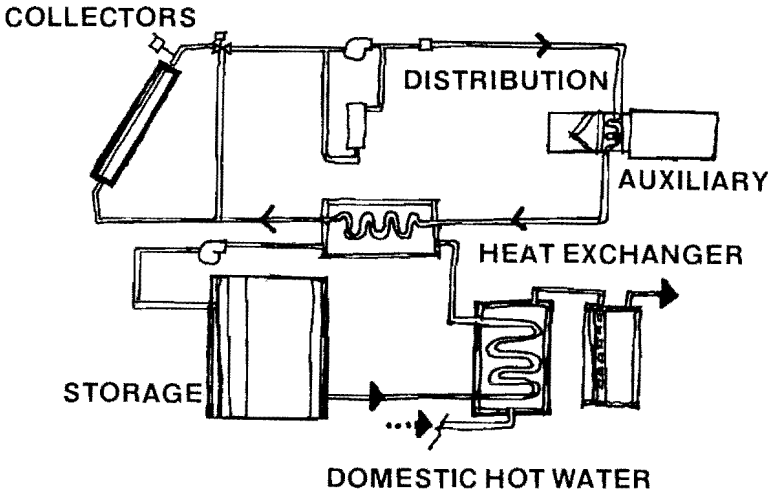
STORAGE: Preheated water is pumped from the heat exchanger to a 1,250 gallon water tank in the basement. When heat is required from storage, the stored water is pumped to the coil in the return duct of the auxiliary system.

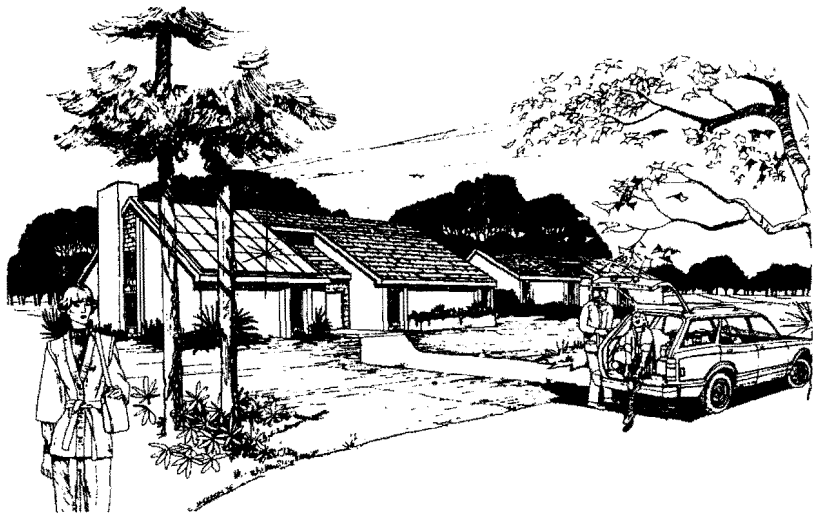
DISTRIBUTION: Forced air over solar heated coil.

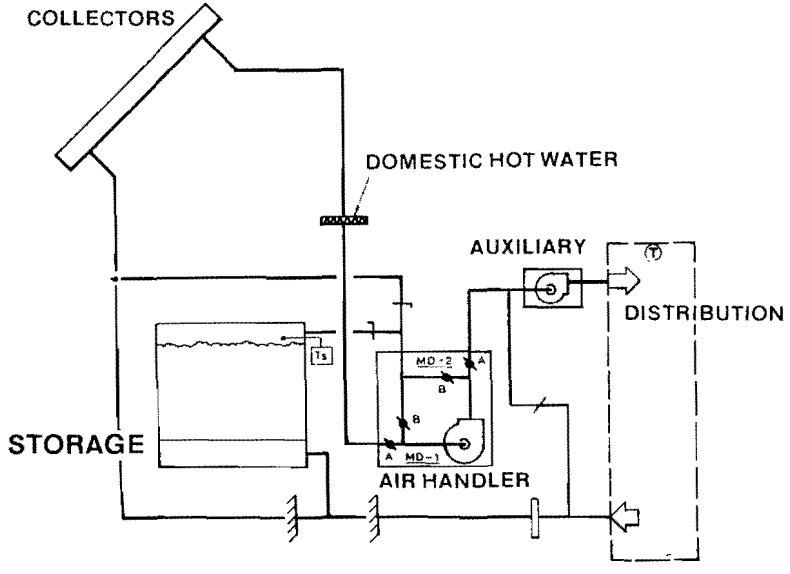
AUXILIARY ENERGY SYSTEM: An electric furnace with a capacity of 34,130 BTUH supplies auxiliary heat.

DOMESTIC HOT WATER: A shell and tube heat exchanger transfers heat from the storage tank to a 52 gallon preheat tank, adjacent to the conventional DHW heater.

MODES OF OPERATION: Collector to storage (via heat exchanger), collector to house (via heat exchanger), storage to house, auxiliary to house, storage to auxiliary to house, DHW preheat.







PROJECT INFORMATION:

BUILDER/APPLICANT: Development Technology Inc.
DESIGNER: Dharma Designers
SOLAR SUB: Applied Solar Technology, Ltd.
LOCATION: Columbia, MD
LATITUDE: 39°N
HOUSING TYPE: SFD, 2 Units
AREA: 1,572, 1,610 sq. ft.
CLIMATIC DATA:
HEATING DD: 4,729
COOLING HRS:
DESIGN TEMP: WINTER: 0° F
SUMMER: 95° F
HORIZ. INSOL. JAN. DAY: 654 BTU/ft²
% SUN/YR: 55%

BUILDING DESCRIPTION/ENERGY CONCERNS

This project involves 2 new single family units of 1,572 sq. ft. and 1,610 sq. ft. with 3 bedrooms each. Energy conservation features include vertical shading devices which reduce heat gain, an optional greenhouse which forms an airlock at the entry, minimal windows on the west side which improves thermal resistance, and overhangs on south, west and east faces which reduce summer heat gain.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 58% and 64%

COLLECTOR: Flat plate roof mounted air collectors (312 & 315 sq. ft. for respective buildings) provide solar heat for the houses. The Solaron collectors are facing due south at a 45° angle. An air handling unit forces air through the collector to storage.

STORAGE: 175 cu. ft. of rock in a concrete box on the first floor constitutes the storage for this system. The Solaron air handling unit forces preheated air into the living space.

DISTRIBUTION: Forced hot air.

AUXILIARY ENERGY SYSTEM: A heat pump with a capacity of 35,000 BTUH supply auxiliary and heating assist.

DOMESTIC HOT WATER: A preheat coil diverts incoming city water and routes it through a coil in the collector-storage duct.

MODES OF OPERATION: Collector to house (via air handler), collector to storage (via air handler), storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.

ACTIVE HEATING & DHW | 2 SFD NEW | 4729 DD | MARYLAND

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BUILDER/APPLICANT: Joseph Barnes & Sons, Inc.
DESIGNER: Creative Design Associates
SOLAR SUB: Roy Larry Schlein Associates
LOCATION: Cherry Hill, NJ
HOUSING TYPE: SFD, 1 Unit
AREA: 1,800 sq. ft.
LATITUDE: 39°48'N

BUILDER/APPLICANT: *J. D. Evans*
DESIGNER: Clark Finefrock Sackett, Arch.
SOLAR SUB: Applied Solar Technology
LOCATION: Columbia, MD
HOUSING TYPE: SFD, 4 Units
CLIMATIC DATA:
HEATING DD: 4,729
DESIGN TEMP: WINTER: 0° F
HORIZ. INSOL. JAN. DAY: 654 BTU/ft²

LATITUDE: 38°51'N
AREA: 2,252 sq. ft.

COOLING HRS: 1,200
SUMMER: 95° F
% SUN/YR: 55%

BUILDING DESCRIPTION/ENERGY CONCERNS

These single family homes have 2,252 sq. ft. of floor area and 3 bedrooms. Passive design concerns include placing most window openings on the south face, shaded at both levels, with the length of the building facing due south.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 63%

COLLECTOR: 374 sq. ft. of flat plate, double glazed water collector is integrated into the structure of the garage roof, facing due south at a 45° tilt. Manufactured by Revere, these collectors drain down to prevent freezing, and use water to carry the sun's heat to an immersion heat exchanger in the water storage.

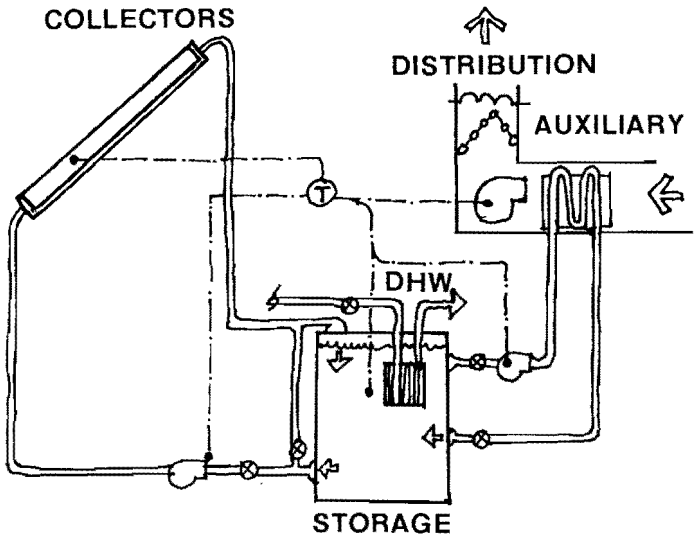
STORAGE: 550 gallons of water are located in the basement in a steel tank. Water is circulated by pump to a coil heat exchanger in the ducts, where heat is mixed with return air and blown through the auxiliary system to the house.

DISTRIBUTION: Forced air.

AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by an electric heat pump coil in the air handling system. Backup is then provided by a 9 KW electric resistance heater in the supply air duct.

DOMESTIC HOT WATER: DHW is preheated by a water coil immersed in solar storage tank, in a closed loop with the DHW tank.

MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.



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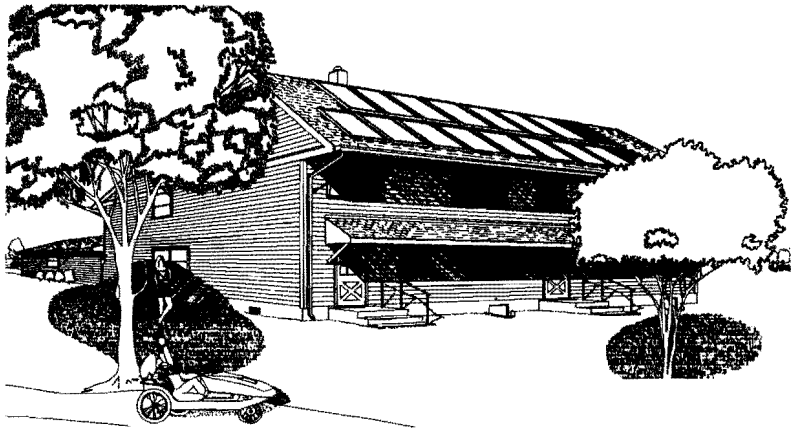


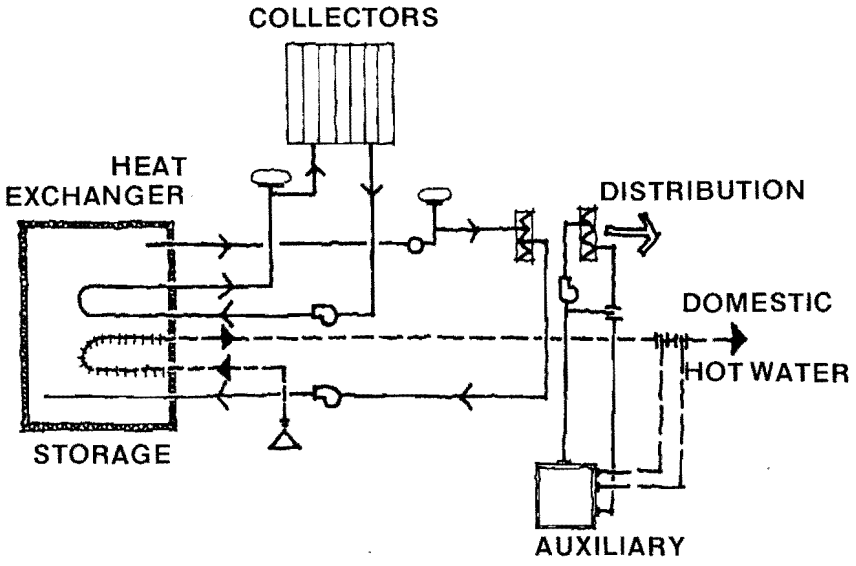
BUILDER/APPLICANT: Joseph Barnes & Sons, Inc.
DESIGNER: Creative Design Associates
SOLAR SUB: Roy Larry Schlein Associates
LOCATION: Cherry Hill, NJ
LATITUDE: 39°48'N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,800 sq. ft.
CLIMATIC DATA:
HEATING DD: 4,980
COOLING HRS:
DESIGN TEMP: WINTER: 5° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 510 BTU/ft²
% SUN/YR: 55%

BUILDING DESCRIPTION/ENERGY CONCERNS

This four bedroom single family detached house encompasses 1,800 sq. ft. of floor area. Energy conservation features include an open southern exposure, well shaded from the summer sun. 1" rigid insulation has been added to the standard batt insulation, as well as insulated aluminum siding. The garage is located to the northwest helping to shield the house from winter winds, and late afternoon summer sun.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 55%



COLLECTOR: 318 sq. ft. of liquid flat plate collectors have been standoff mounted on a south sloping roof at a 52.5° tilt. These Daystar liquid collectors use a folded polymer heat trap to deal with overheating in summer. A Solarguard propylene glycol antifreeze acts as the transfer media, carrying heat from the collector through a closed heat exchanger loop in storage.

STORAGE: 750 gallons of water storage have been insulated with 2-3" of rigid insulation and placed underground. Another closed liquid loop pumps heated water from storage to a fancoil in the return air ducts of the hot air distribution system.

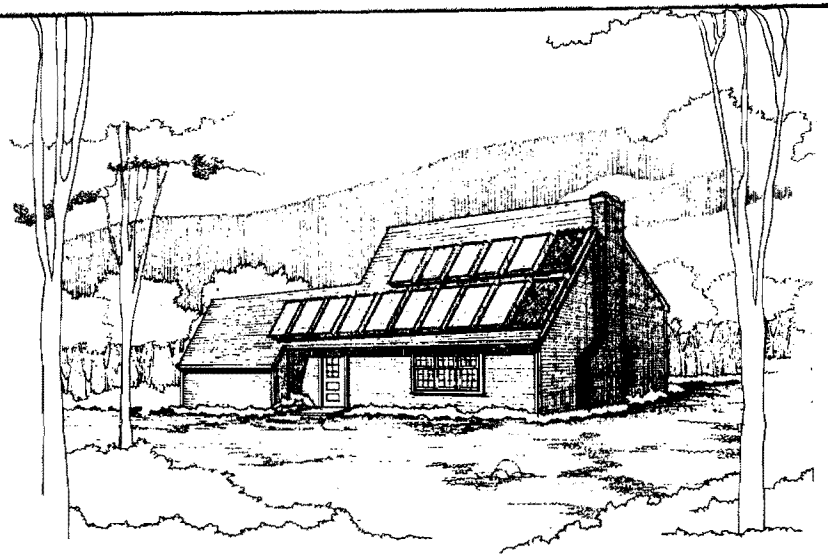
DISTRIBUTION: The central furnace fan blows forced hot air to fancoil units.

AUXILIARY ENERGY SYSTEM: An oil fired hot water boiler of 104,500 BTUH capacity pumps heated water to the fancoil units for auxiliary or back-up energy.

DOMESTIC HOT WATER: City water supply passes through a finned tube heat exchanger in solar storage to preheat water before delivery to a conventional 80 gallon domestic hot water tank.

MODES OF OPERATION: Collector to storage, storage to auxiliary to house, DHW preheat.

DESIGNER: Robert Botton, Arch., Roy Larry Schlein Assoc., Inc.
SOLAR SUB: Meenan Oil Co.
LOCATION: Northampton Twp., PA
LATITUDE: 39°53'N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,950 sq. ft.
CLIMATIC DATA:
HEATING DD: 5,001
COOLING HRS:
DESIGN TEMP: WINTER: 5° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 570 BTU/ft²
% SUN/YR: 55%



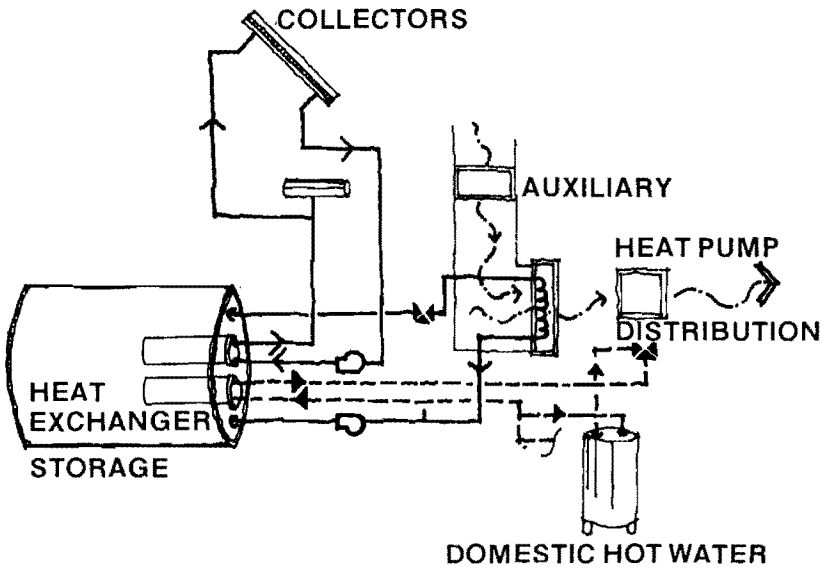
BUILDING DESCRIPTION/ENERGY CONCERNS

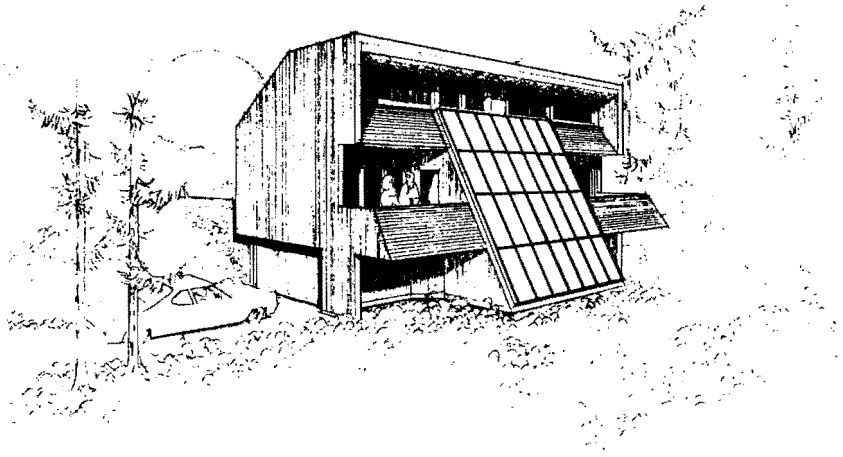
This single family home encompasses 1,950 sq. ft. of space and 3 bedrooms. Energy conservation features include shading of windows on the south face, and fewer windows on the east and west faces with the length of the house facing south. Insulation improvements include the perimeter wall in the basement which is 10" thick and sealed, the ceiling with 6" insulation, and insulated siding. Windows are all wood with thermal breaks. The attic/roof space is vented for summer cooling. Shower head energy savers have also been included.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 62%

COLLECTOR: 296.8 sq. ft. of flat plate, single glazed liquid collectors, with a heat dump panel, are located on the roof of the building with standoff mounting at a 68° tilt south. Manufactured by Daystar Corp., these collectors use antifreeze liquid (60% glycol, 40% water) to transfer the sun's heat to a heat exchanger in water storage.
STORAGE: 700 gallons of water are located in an insulated steel tank underground. The water is circulated to hot water heating coils, where an air handling unit blows heated air to the living space.
DISTRIBUTION: Forced hot air over hot water heating coils.
AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by a heat pump in the air handling unit. Backup energy is provided by a 290 gallon underground oil tank connected to a hot air furnace.
DOMESTIC HOT WATER: Cold water supply travels through storage in finned copper tubing where a double heat exchanger transfers storage heat to water supply. A conventional DHW tank provides boost heat.
MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.



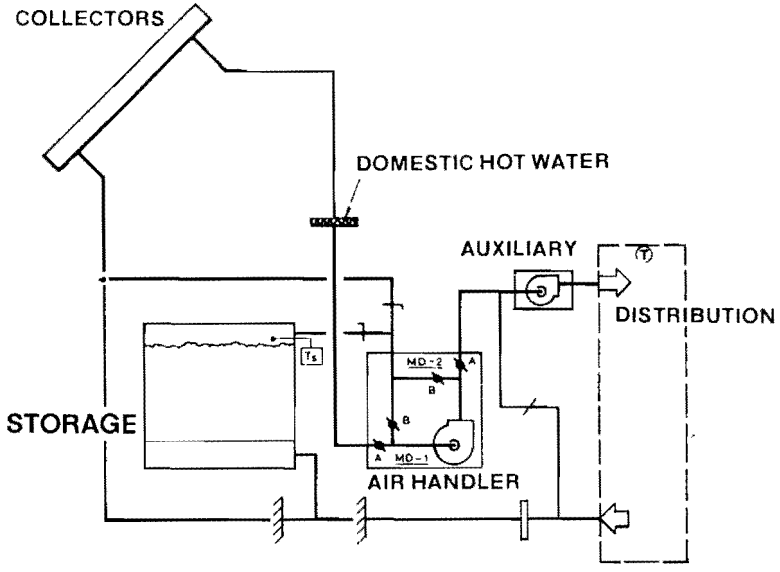


PROJECT INFORMATION:

BUILDER/APPLICANT: Washington Natural Gas Co.
DESIGNER: The Mithun Associates
SOLAR SUB: Gas Appliance Service
LOCATION: Seattle, WA
LATITUDE: 47°30'N
HOUSING TYPE: SFD, 1 Unit
AREA: 2,607 sq. ft.
CLIMATIC DATA:
HEATING DD: 5,145
COOLING HRS:
DESIGN TEMP: WINTER: 15° F
SUMMER: 85° F
HORIZ. INSOL. JAN. DAY: 575 BTU/ft²
% SUN/YR: 45%

BUILDING DESCRIPTION/ENERGY CONCERNS

This single family home encompasses 2,607 sq. ft. of space and 3 bedrooms. Its design includes energy conservation features such as having no windows on the north face of the building, placing the garages at the northwest corner of the house in order to act as a thermal insulation barrier, using the north-south sloping site to maximize area of above grade southern exposures and minimize square footage of northern face exposure. The design also includes shading with terraces on the southern face.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 47%

COLLECTOR: 546 sq. ft. of flat plate, air collector is directly mounted to the south sloping wall at a 55° tilt. Manufactured by Solaron Corp., these collectors use air to transfer the sun's heat to rock storage.

STORAGE: 273 cu. ft. of crushed rock is located in the basement. From here, or directly from collector, a central air handling unit blows heated air to the living space.

DISTRIBUTION: Forced air.

AUXILIARY ENERGY SYSTEM: Supplied by a gas-fired furnace, located in the basement with a capability of 100,000 BTUH, the furnace also acts as a backup heating system.

DOMESTIC HOT WATER: DHW is preheated in coils located in the collector air circuit on its way to an 80 gallon hot water storage tank. Water then circulates to a conventional gas-fired 80 gallon hot water heater. This heater can act alone as the backup system.

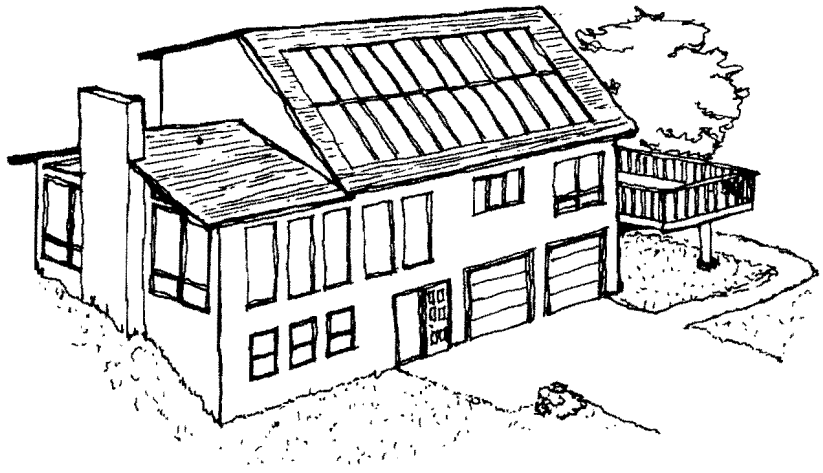
MODES OF OPERATION: Collector to house, collector to storage, storage to house, storage to auxiliary to house, DHW preheat.

BUILDER/APPLICANT: Perl-Mack Enterprises, Inc.
DESIGNER: John Tuttle
SOLAR SUB: American Heliothermal Corp.
LOCATION: Denver, CO
HOUSING TYPE: SFD, 25 Units
LATITUDE: 39°48'
AREA: 1,324-1,695 sq. ft.

BUILDER/APPLICANT: David L. Vickerman, Inc.
DESIGNER: David L. Vickerman, Inc.
SOLAR SUB: Solaron, Inc.
LOCATION: Evergreen, CO
HOUSING TYPE: SFD, 1 Unit
CLIMATIC DATA:
HEATING DD: 5505
DESIGN TEMP: WINTER: 3° F
HORIZ. INSOL. JAN. DAY: 922 BTU/ft²

LATITUDE: 39°05'
AREA: 2,231 sq. ft.

COOLING HRS:
SUMMER: 92° F
% SUN YR: 70%



BUILDING DESCRIPTION/ENERGY CONCERNS

This new single family home has 2,231 sq. ft. of floor area. The foam formwork used for the concrete walls is permanent and provides the insulating mass. The north wall is built into a hill and has few openings, minimizing heat losses. Other energy conserving features include overhangs on the south and west walls which provide shade, and large trees to the northeast which reduce convective losses.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 67.9%

COLLECTOR: The Solaron flat plate air collectors are mounted at a 45° angle on the roof facing 20° west of south. They cover 429 sq. ft. Air flows through the collectors to carry heat to storage.

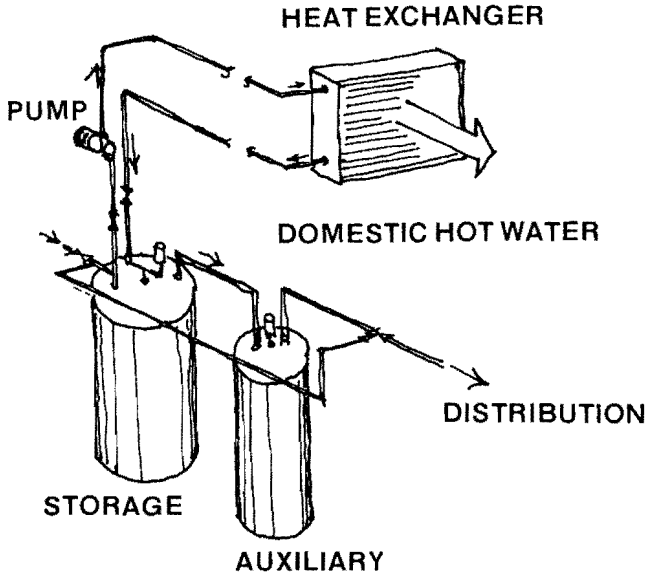
STORAGE: A rock bin of 215 cu. ft. located in the garage is the storage component for the system.

DISTRIBUTION: A central air handling unit blows air across the rock storage for forced air distribution.

AUXILIARY ENERGY SYSTEM: A gas-fired furnace with a 12,000 BTUH capacity provides auxiliary energy.

DOMESTIC HOT WATER: City water supply passes through a finned coil heat exchanger in the duct between collector and storage. The water is preheated before reaching an 80 gallon conventional electric hot water heater.

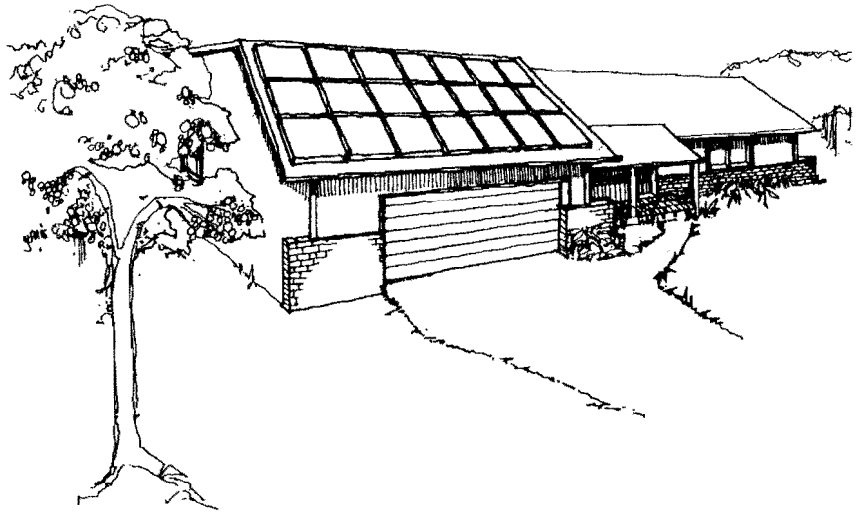
MODES OF OPERATION: Collector to storage (via air handling unit), collector to house (via air handling unit), storage to house (via air handling unit), storage to auxiliary to house, auxiliary to house, DHW preheat.



FOR TYPICAL SOLARON HEATING SYSTEM, SEE PAGE 13

PROJECT INFORMATION:

BUILDER/APPLICANT: Perl-Mack Enterprises, Inc.
DESIGNER: John Tuttle
SOLAR SUB: American Heliothermal Corp.
LOCATION: Denver, CO — **LATITUDE:** 39°48'
HOUSING TYPE: SFD, 25 Units — **AREA:** 1,324-1,695 sq. ft.
CLIMATIC DATA:
HEATING DD: 5,505 — COOLING HRS:
DESIGN TEMP: WINTER: −3° F — SUMMER: 91° F
HORIZ. INSOL. JAN. DAY: 922 BTU/ft² — % SUN/YR: 67%

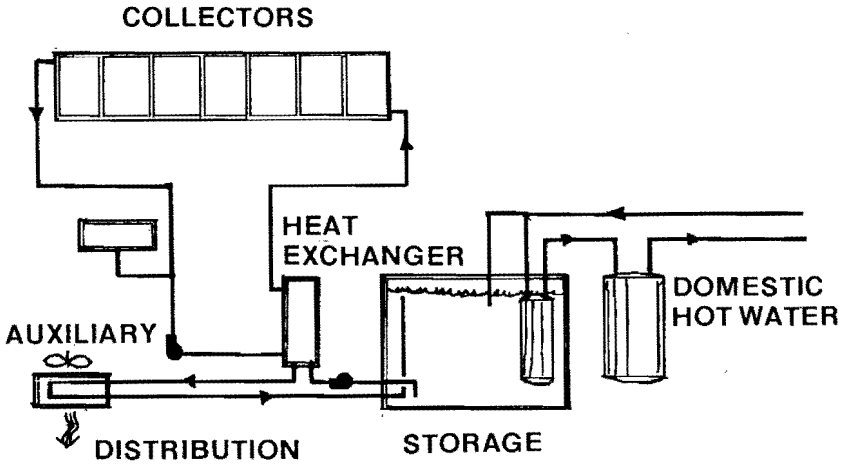


BUILDING DESCRIPTION/ENERGY CONCERNS

This project consists of 25 new single family detached homes designed with three different plans, and developed with varying elevations. Both one story and two story types have 3 bedrooms. Minimizing window openings towards the east and west conserves energy by reducing winter heat loss and summer heat gain. Overhangs shade the building from the summer sun.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 69%



COLLECTOR: 365-426 sq. ft. of Miromit liquid flat plate collectors are mounted to the sloping roof and face due south. A solution of water and glycol transports heat to a heat exchanger, where heat is transferred to either distribution or storage.

STORAGE: 1,000 gal. of water are stored in a pre-cast concrete tank, surrounded by 6" of insulation, and located in the basement of each unit. Hot water from storage is pumped through a coil in the return air duct where the air is preheated before going through the furnace to the living space.

DISTRIBUTION: Forced hot air.

AUXILIARY: A gas-fired furnace supplies auxiliary heat with a 65,255 BTUH capacity.

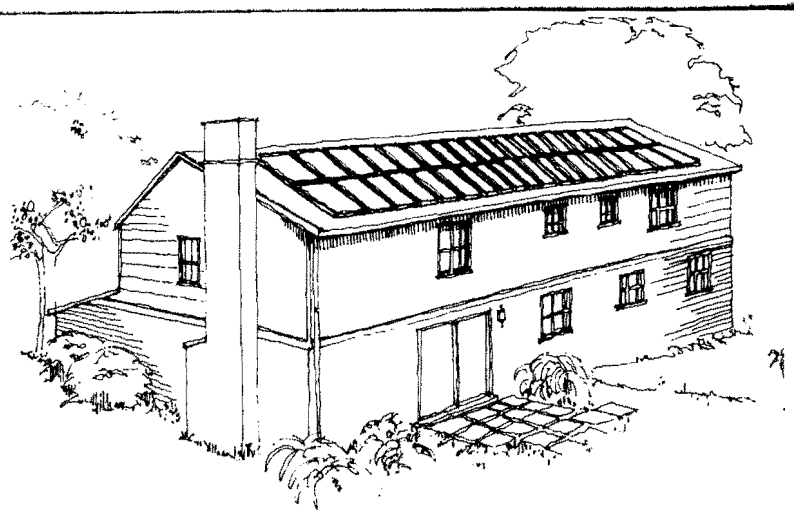
DOMESTIC HOT WATER: A double wall heat exchanger in storage transfers heat to a 40 gal. water tank. This tank also acts in the auxiliary capacity of a conventional hot water heater.

MODES OF OPERATION: Collector to storage (via heat exchanger), collector to house (via heat exchanger), storage to house, auxiliary to house, DHW preheat.

BUILDER/APPLICANT: Moulder Corp.
DESIGNER: Davidson Industries
SOLAR SUB: Williams Comfort Air, Inc.
LOCATION: Greenwood, IN
HOUSING TYPE: SFD, 1 Unit
AREA: 1,769 sq. ft.
LATITUDE: 40°N

DESIGNER: Larry D. Norris
SOLAR SUB: Solar Industries, Inc.
LOCATION: Butler, OH
HOUSING TYPE: SFD, 1 Unit
CLIMATIC DATA:
HEATING DD: 5,647
DESIGN TEMP: WINTER: −4° F
HORIZ. INSOL. JAN. DAY: 540 BTU/ft²

LATITUDE: 40°N
AREA: 2,340 sq. ft.
COOLING HRS:
SUMMER:
% SUN/YR: 56%



BUILDING DESCRIPTION/ENERGY CONCERNS

This single family home encompasses 2,340 sq. ft. of space with 5 bedrooms. Energy conservation features include locating the garage on the northwest corner to aid in insulating the living space in summer and winter. The long side of house is oriented on the east-west axis to provide maximum area on the southern face for collector location and winter heat gain to the living space.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 42.3%

COLLECTOR: 552 sq. ft. of flat plate collectors are directly mounted on the south facing roof of the house at an 18° tilt. Manufactured by Revere, these collectors use water (with the drain down method to prevent freezing in the circuit) and transfer the sun's heat to the water storage.

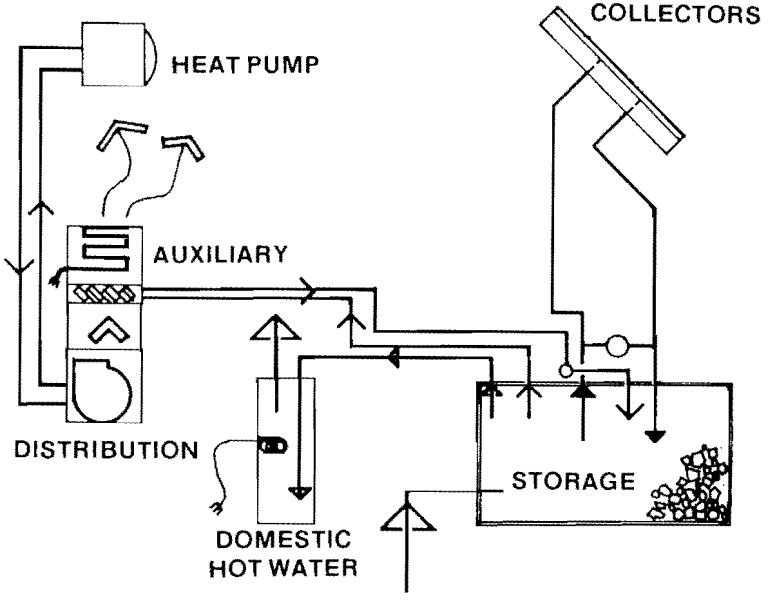
STORAGE: 3,000 gallons of water are stored in insulated (3" rigid insulation) steel tanks and set in an insulated rock bed located in the basement. From here, a water coil exchanges heat with the air which is supplied to the space.

DISTRIBUTION: Forced hot air.

AUXILIARY ENERGY SYSTEM: Provided by an electric heat pump and electric resistance heaters, the total auxiliary energy system provides 65,000 BTU.

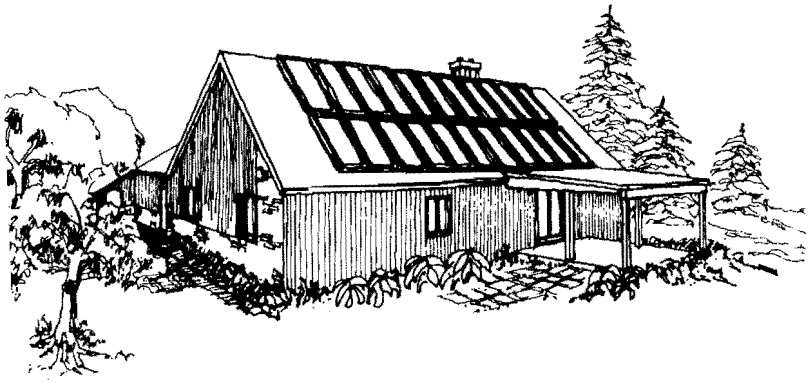
DOMESTIC HOT WATER: City water passes through a preheat coil in storage on the way to a conventional water heater. Back-up energy is provided by an electric heater located in the hot water tank.

MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.



PROJECT INFORMATION:

BUILDER/APPLICANT: Moulder Corp.
DESIGNER: Davidson Industries
SOLAR SUB: Williams Comfort Air, Inc.
LOCATION: Greenwood, IN
LATITUDE: 40°N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,769 sq. ft.
CLIMATIC DATA:
HEATING DD: 5,669
COOLING HRS:
DESIGN TEMP: WINTER: 0° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 553 BTU/ft²
% SUN/YR: 56%

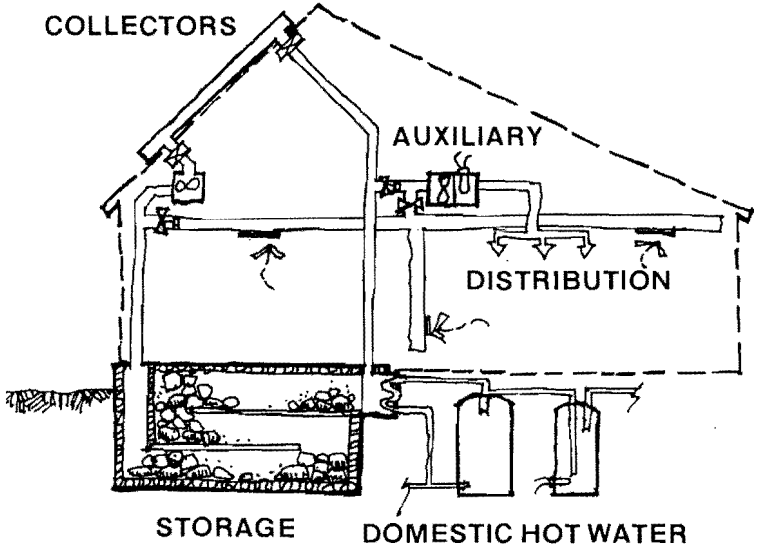


BUILDING DESCRIPTION/ENERGY CONCERNS

This single family home incorporates 1,769 sq. ft. of floor area and has 3 bedrooms. It conserves energy by minimizing window openings on all faces, using 6" blanket insulation in the walls (studs are 2x6), 12" blown insulation in the ceiling, and 1" of rigid insulation in the roof.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 93.4%



COLLECTOR: 704 sq. ft. of flat plate air collectors, manufactured by Solar Space Energy Products Co., are direct mounted on the roof, facing south at a 45° tilt. Air transfers the sun's heat to rock storage with the aid of a fan series.

STORAGE: 850 cu. ft. of rock storage is located in the crawl space of the house and completely surrounded by rigid insulation.

DISTRIBUTION: Fans blow air over the heated rocks and then into the living space.

AUXILIARY ENERGY SYSTEM: Auxiliary energy is provided by an electric furnace with 53,311 BTU capacity.

DOMESTIC HOT WATER: City water is pumped through a copper tube-aluminum fin hot water coil in the collector-storage circuit. The water in the coil draws heat from the air and is then pumped to a tempering storage tank adjacent to a conventional hot water tank.

MODES OF OPERATION: Collector to house (via air handler), collector to storage (via air handler), storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.

NEW YORK

5785 DD

1 SFD NEW

ACTIVE HEATING & DHW

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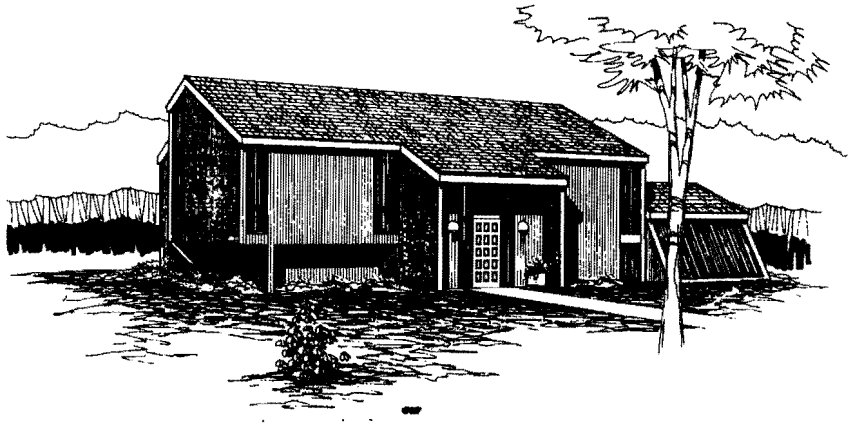
BUILDER/APPLICANT: Suntech Homes, Inc.
DESIGNER: Solar Shelter, Inc.
SOLAR SUB: Suntech Homes, Inc.
LOCATION: Chester, NY
HOUSING TYPE: SFD, 1 Unit
CLIMATIC DATA:
HEATING DD: 5,785
DESIGN TEMP: WINTER: 0° F
HORIZ. INSOL. JAN. DAY: 481 BTU/ft²

LATITUDE: 41.5°N
AREA: 1,720 sq. ft.

COOLING HRS:
SUMMER:
% SUN/YR: 59%



BUILDING DESCRIPTION/ENERGY CONCERNS

This 2-3 bedroom single family house encompasses 1,720 sq. ft. of space. Energy conservation features include locating the long dimension of the building facing north and south thus reducing window area east and west. Shading angles have been calculated to design overhangs on the southern side—minimizing summer sun and optimizing winter. In addition, the glass wall collector has fold down reflector doors to reduce heat loss.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 56%

COLLECTOR: 128 sq. ft. of flat plate air collector has been mounted on a "solar furnace" shed at ground level, at a 60° tilt. This Solar Shelter, Inc. collector uses vertical vane diffusers to solar heat air on its way to brick storage.

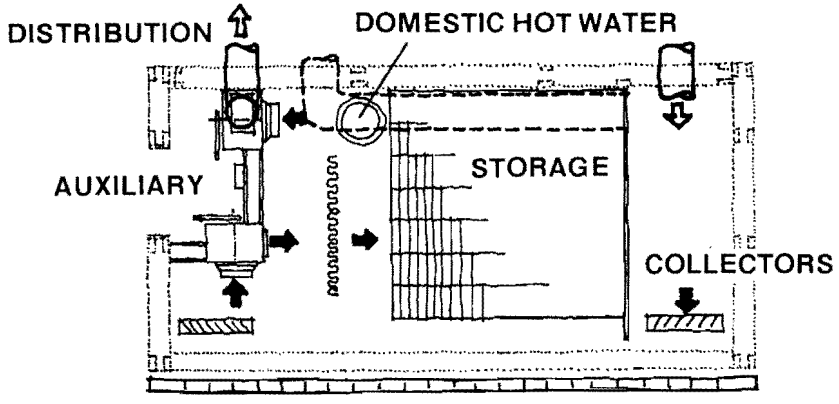
STORAGE: 360 cu. ft. of facing brick have been used to construct a solid solar storage adjacent to the house. Heated air from the collectors is then blown through the holes in the heavily insulated brick stack for heat storage.

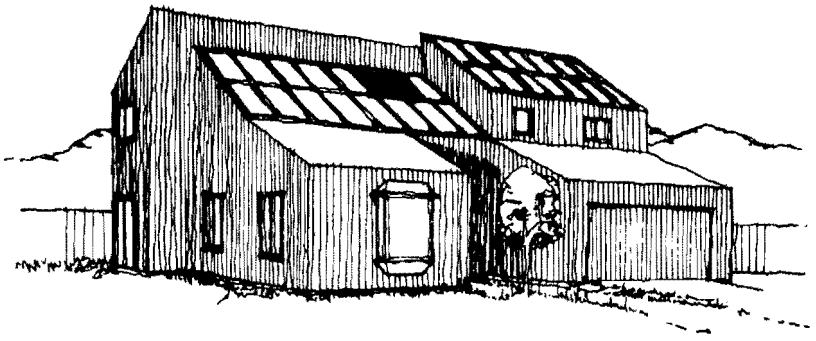
DISTRIBUTION: Drawing air directly from the collector or from the storage module, hot air is blown through the auxiliary to the house supply. Return air from the house goes directly to the collector or recirculates through storage to supply again.

AUXILIARY ENERGY SYSTEM: A heat pump duct heater of 25,000 BTUH capacity provides auxiliary energy.

DOMESTIC HOT WATER: The collectors airborne heat is transferred by a copper fancoil to city water drawn from a warmed hot water tank located in the storage module. A second 52 gallon conventional electric hot water heater is thus fed with preheated city water.

MODES OF OPERATION: Storage to house, collector to storage, auxiliary to house, storage to auxiliary to house, DHW preheat.





PROJECT INFORMATION:

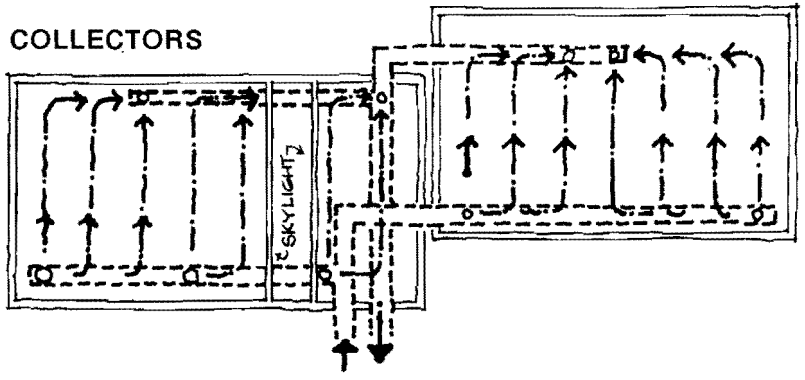
BUILDER/APPLICANT: Ervin Bell
DESIGNER: Ervin T. Bell, Arch.
SOLAR SUB: Myers Heating & Vent.
LOCATION: Boulder, CO
LATITUDE: 39°N
HOUSING TYPE: SFD, 1 Unit
AREA: 2,653 sq. ft.
CLIMATIC DATA:
HEATING DD: 6,283
COOLING HRS:
DESIGN TEMP: WINTER: 0° F
SUMMER: 92° F
HORIZ. INSOL. JAN. DAY: 922 BTU/ft²
% SUN/YR: 70%

BUILDING DESCRIPTION/ENERGY CONCERNS

This single family home encompasses 2,653 sq. ft. of floor area and 3 bedrooms. Energy conservation features include increased insulation with double insulated windows in wood frames, and double entry doors with an air lock. In addition, the length of the house faces south with the entry stepped in, shaded from the summer sun.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 65.1%



FOR TYPICAL SOLARON HEATING SYSTEM, SEE PAGE 13

COLLECTOR: 546 sq. ft. or 28 panels of flat plate, air collectors are integrated into the roof facing due south at a 35° tilt. Panels are located at 2 different heights according to roof planes. Manufactured by Solaron, these collectors use air to transfer the sun's heat to rock storage.

STORAGE: 232 cu. ft. of crushed rock are located in the basement near the furnace room. From storage, or directly from the collector, a central air handling unit blows heated air to the living space.

DISTRIBUTION: Forced hot air.

AUXILIARY ENERGY SYSTEM: Supplied by a gas furnace located in the basement with 84,000 BTUH capacity.

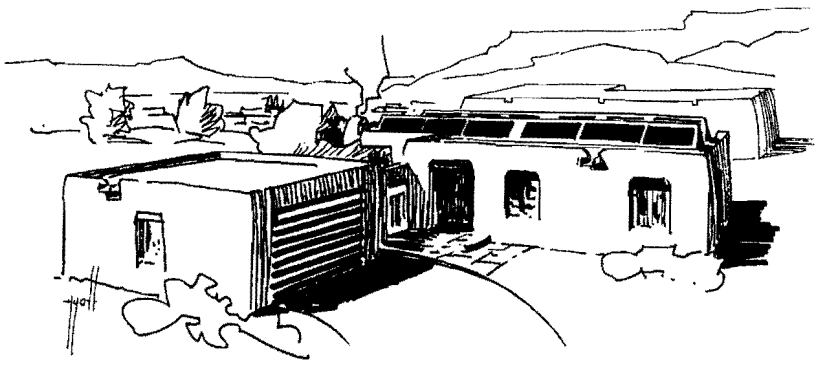
DOMESTIC HOT WATER: DHW is preheated in a heat exchange coil located in the hot air circuit between solar collector and storage. This coil preheats water for an 80 gallon storage tank which circulates to an 80 gallon conventional hot water heater tank. This standard heater tank provides the back-up energy.

MODES OF OPERATION: Collector to house, collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.

BUILDER/APPLICANT: Stanley Associates
DESIGNER: Francis E. Stanley, Architect
SOLAR SUB: Solar Seven Industries, Inc.
LOCATION: Santa Fe, NM
LATITUDE: 35°40'N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,470 sq. ft.
CLIMATIC DATA:
HEATING DD: 6,350
COOLING HRS:
DESIGN TEMP: WINTER: 10° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 1,090 BTU/ft²
% SUN/YR: 76%

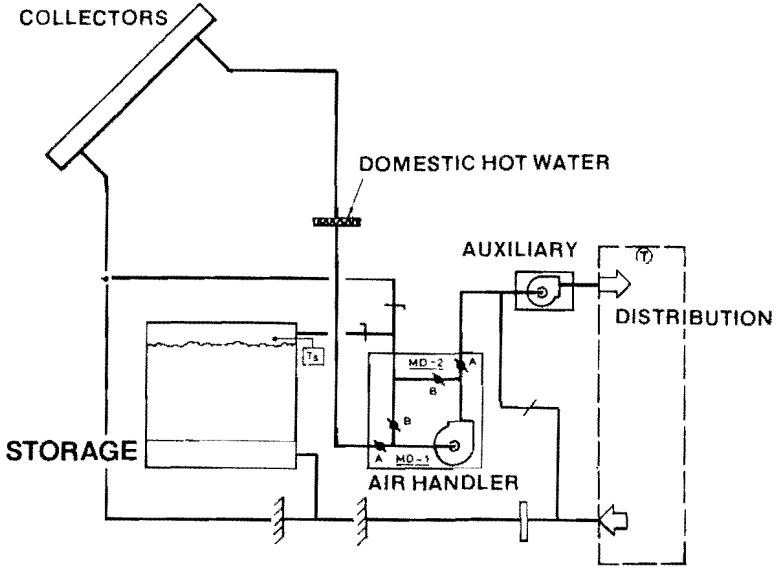
BUILDING DESCRIPTION/ENERGY CONCERNS

This single family detached house with 3 bedrooms is oriented with the long axis facing south. Other energy conservation features include windowless east and west walls and heavy fireplace mass as thermal insulation. Extra insulation has been added to the ceiling against heat loss/gain. Natural ventilation cools the interior during warm periods. Window area has been reduced, and insulated glass added. A 5' west wall shades an atrium patio from the western sun. A major new energy feature is a plug in service module for packaging furnaces, air handling ducts, DHW systems. (Developed with Alcoa Construction Systems, Inc.)



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 63.5%



COLLECTOR: 236 sq. ft. of flat plate air collectors have been mounted on a south sloping roof at a 45° tilt. Manufactured by Solar Seven Industries, Inc., the collectors are integrated with the roof located over a built-up attic containing the air duct heat transport system and a fan to carry heat to rock storage.

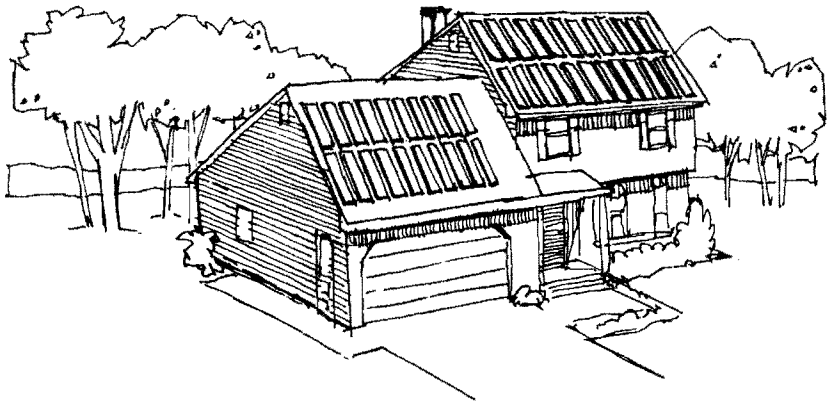
STORAGE: 120 cu. ft. of rock have been placed in an insulated reinforced concrete box underground with 2" insulation. Storage can also be cooled during summer nights to provide daytime relief.

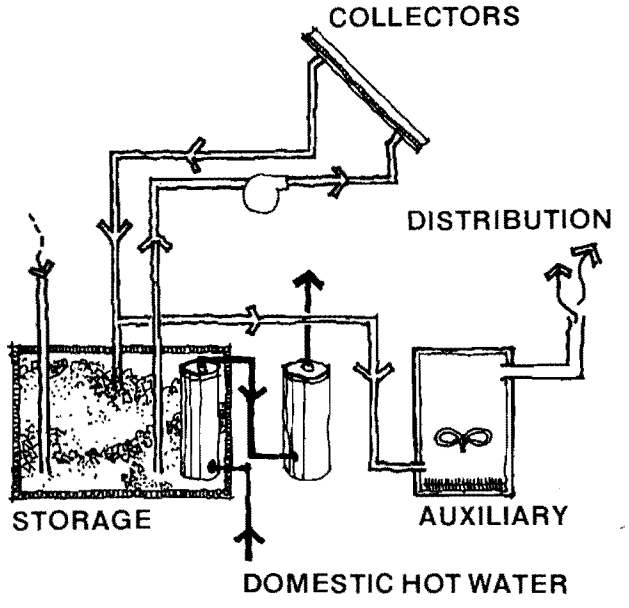
DISTRIBUTION: A central air controller blows air over rock storage to a forced air distribution system.

AUXILIARY ENERGY SYSTEM: Auxiliary and backup energy is supplied by a gas-fired hot air furnace located with the air handler.

DOMESTIC HOT WATER: City water supply is pumped through a heating coil in the collector to storage duct circuit. This finned coil provides preheated water to an 80 gallon conventional hot water heater.

MODES OF OPERATION: Collector to house (via air handler), collector to storage (via air handler), storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.





PROJECT INFORMATION:

BUILDER/APPLICANT: Homes by Stan-Jim Inc.
DESIGNER: Homes by Stan-Jim Inc.
SOLAR SUB: Solar Energy Engineering
LOCATION: Hubbard, OH
LATITUDE: 41°14'N
HOUSING TYPE: SFD, 4 Units
AREA: 932-1,813 sq. ft.
CLIMATIC DATA:
HEATING DD: 6,417
COOLING HRS:
DESIGN TEMP: WINTER: −10° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 530 BTU/ft²
% SUN/YR: 50%

BUILDING DESCRIPTION/ENERGY CONCERNS

This project involves 4 single family homes of 3 bedrooms, varying from 932 to 1,813 sq. ft. Energy conservation features include shading of windows on south, placement of garage on west to minimize late afternoon heat gain, and minimal windows on east and west faces also to lessen summer heat gain.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 44%-59%

COLLECTOR: Produced by Solar Energy Products, this flat plate collector uses air to transport heat to storage. On the different models, the collectors range from 328 to 528 sq. ft. and tilts range from 23° to 45°. The collectors are integrated into the roof structure.

STORAGE: The storage bins are filled with rocks and are either buried behind the house or placed in the basement. Their volumes range from 270 to 850 cu. ft. A fan blows air across the rocks, then through the furnace to heat the living space.

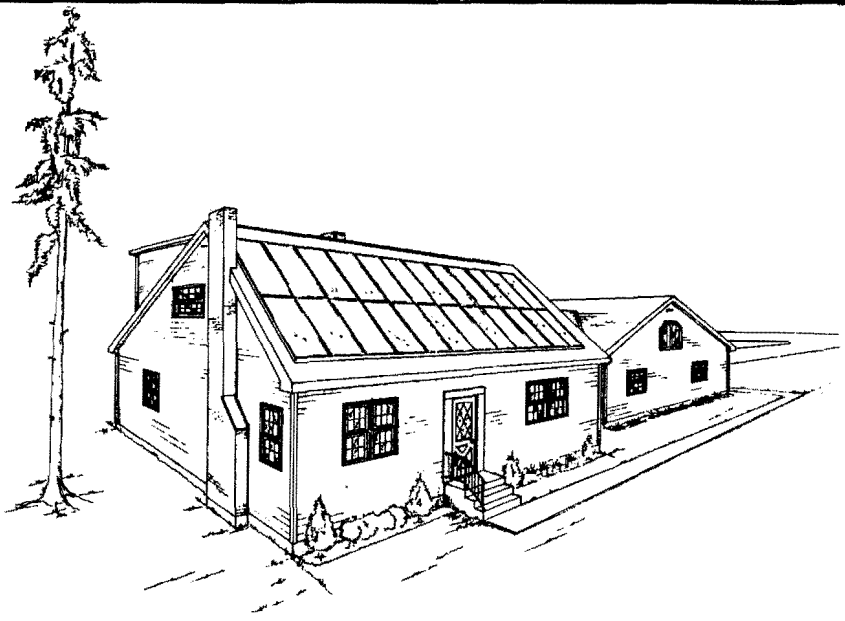
DISTRIBUTION: Forced hot air.

AUXILIARY ENERGY SYSTEM: Conventional oil furnaces with capacities from 78,000-100,000 BTUH supply auxiliary heat with forced air distribution.

DOMESTIC HOT WATER: The conventional 50 gallon hot water heater is supported by a 120 gallon tank buried in the rock storage. Heat is transferred directly from rocks around the walls of the steel water tank.

MODES OF OPERATION: Collector to storage (via air handling unit), storage to house (via air handling unit), auxiliary to house, storage to auxiliary to house, and DHW preheat.

PROJECT INFORMATION:
BUILDER/APPLICANT: Stewart-Teele-Mitchel Construction
DESIGNER: Stewart-Teele-Mitchel Const.
SOLAR SUB: Honeywell Solar Energy Systems
LOCATION: Malta, NY
LATITUDE: 43°N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,900 sq. ft.
CLIMATIC DATA:
HEATING DD: 6,875
COOLING HRS:
DESIGN TEMP: WINTER: 0° F
SUMMER: 88° F
HORIZ. INSOL. JAN. DAY: 470 BTU/ft²
% SUN/YR: 53%



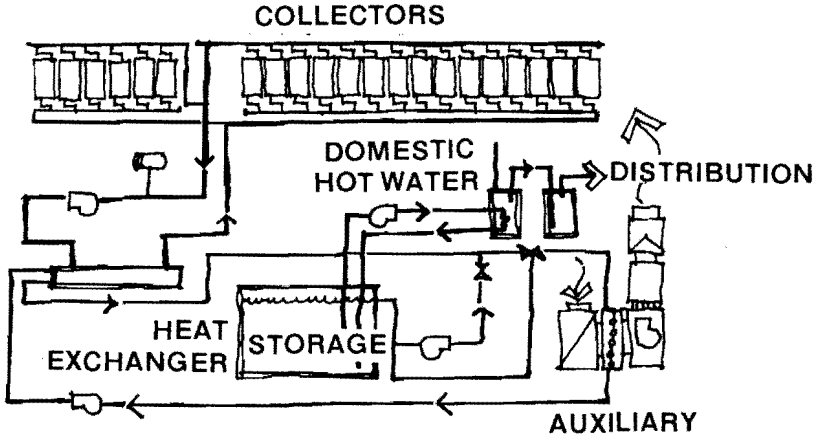
BUILDING DESCRIPTION/ENERGY CONCERNS

This is a new single family Cape Cod type house comprising 1,900 sq. ft. Heat loss and infiltration are resisted by heavy caulking, triple glazing and extra insulation.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 36%

COLLECTOR: The Lennox flat plate collectors cover a 432 sq. ft. area. They are mounted directly on the south facing roof at an angle of 40°. A 50/50 mixture of water and anti-freeze is pumped through the collector then to a double heat exchanger which transfers the collected heat to the storage circuit.



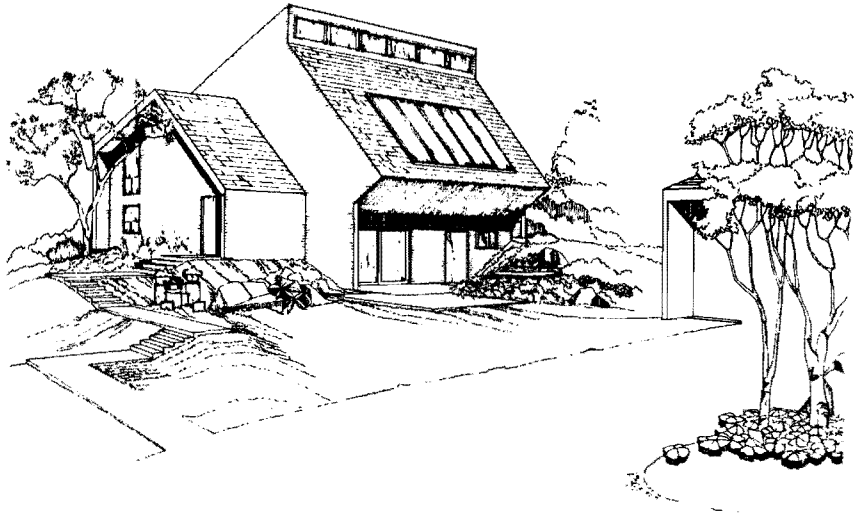
STORAGE: Water carries the heat to a 1,000 gallon water tank. The stored water can then be pumped through a coil in the return air duct of the furnace. The heated water can also by pass storage and go directly to the coil.

DISTRIBUTION: Forced hot air.

AUXILIARY ENERGY SYSTEM: An oil-fired forced air furnace with a capacity of 105,000 BTUH is the auxiliary system.

DOMESTIC HOT WATER: City water passes through a 75 gallon preheat tank which is heated by pumping hot water from storage through a tube-bundle heat exchanger. The preheat water is then carried to a conventional DHW heater of 40 gallons.

MODES OF OPERATION: Collector to house (via heat exchanger), collector to storage (via heat exchanger), storage to house, auxiliary to house, storage to auxiliary to house, DHW preheat.

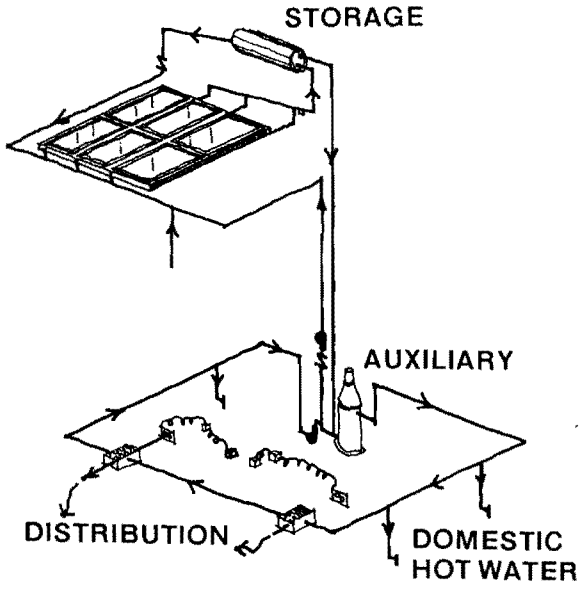


PROJECT INFORMATION:

BUILDER/APPLICANT: TAS Development & Construction
DESIGNER: The Architects Studio
SOLAR SUB: Pickens Electrical, Plumbing & Heating
LOCATION: Pocatello, ID
LATITUDE: 43°N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,800 sq. ft.
CLIMATIC DATA:
HEATING DD: 7,066
COOLING HRS:
DESIGN TEMP: WINTER: −10° F
SUMMER: 90° F
HORIZ. INSOL. JAN. DAY: 740 BTU/ft²
% SUN/YR: 63%

BUILDING DESCRIPTION/ENERGY CONCERNS

This single family house encompasses 1,800 sq. ft. and 3 bedrooms. Energy conservation features which add to the thermal resistance of the house include: earth berming on the east, west, and north sides of the house; windows which are minimized on the north side, and are double glazed; insulation, with 8½" batt insulation in ceiling, 6" insulation in foundation walls and 6" insulation in exterior walls. South face openings are shaded from the summer sun.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 24.3%

COLLECTOR: 80 sq. ft. of flat plate, double glazed, collectors are directly mounted to the south facing roof at a 57° tilt. Manufactured by Piper-Hydro, these collectors use water (continually circulated to prevent freezing in circuit) to transfer the sun's energy to water storage.
STORAGE: 160 gallons of water in a steel tank with 2" fiberglass insulation is located in the roof space near the collectors. From here, heated water passes through a boiler which raises its temperature as needed. Hot water circulates in a heat exchange coil over which supply air is blown to heat the living space.
DISTRIBUTION: Forced hot air.
AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by a gas-fired boiler with 160,000 BTUH capacity, which can act alone as the back-up system.
DOMESTIC HOT WATER: City water supply is taken directly through the collectors, so DHW supply is drawn from the 160 gallon solar storage tank. The auxiliary gas fired boiler acts as DHW back-up as well.
MODES OF OPERATION: Collector to storage, storage to auxiliary to house, auxiliary to house, DHW supply.

ACTIVE HEATING & DHW 1 SFD NEW 7350 DD WISCONSIN

30

BUILDER/APPLICANT: *Theodore A. Kuck*
DESIGNER: Sun Unlimited Research Corp.
SOLAR SUB: Theodore Kuck, P.E.
LOCATION: Lake Park Estate, WI
HOUSING TYPE: SFD, 1 Unit
CLIMATIC DATA:
HEATING DD: 7,350
DESIGN TEMP: WINTER: −15° F
HORIZ. INSOL. JAN. DAY: 535 BTU/ft²

LATITUDE: 43°45'N
AREA: 1,553 sq. ft.

COOLING HRS:
SUMMER:
% SUN/YR: 49%

BUILDING DESCRIPTION/ENERGY CONCERNS

This one story single family house contains 3 bedrooms in 1,553 sq. ft. As energy considerations: roof-supporting piers which stand free from the east facade, have been used to provide both horizontal and vertical summer shading; Southern windows have overhangs to shade from the summer sun; All windows have been provided with storm glazing; and a fireplace adds mass to the north wall, somewhat protecting interior space from winter winds and heat loss.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 59%

COLLECTOR: 264 sq. ft. of flat plate air collectors have been mounted on roof brackets facing south at a 50° tilt. These Sunstone solar energy collectors use a two pass system (backed by 3" of glass fiber insulation) to circulate and heat air.

STORAGE: 419 cu. ft. of crushed stone is located underground in a concrete bin with 2" of rigid insulation, and 10" of cover insulation.

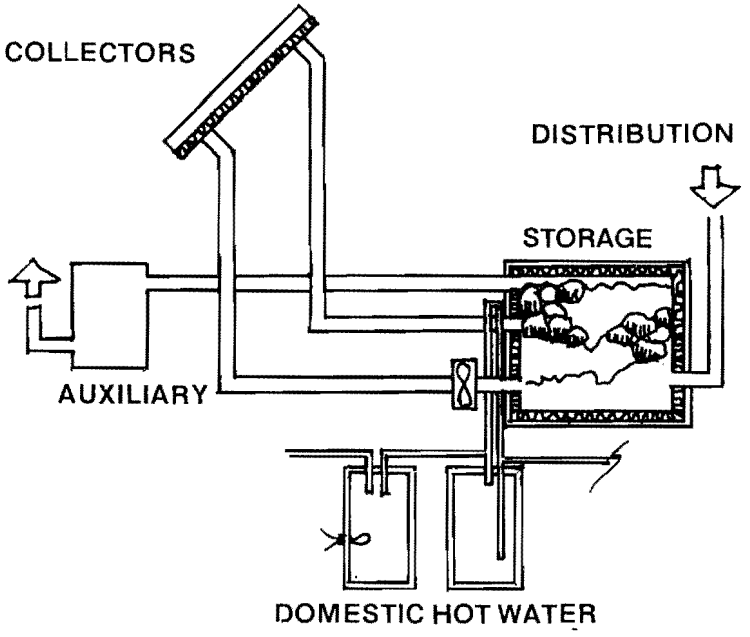
DISTRIBUTION: A single fan draws heated air from storage to distribute heat through a forced hot air system.

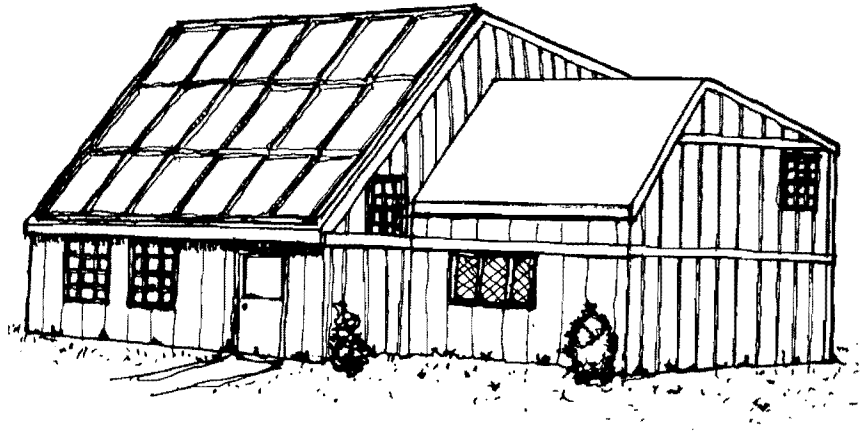
AUXILIARY ENERGY SYSTEM: A standard oil-fired forced air furnace and a heat pump, is used to give 70,000 BTUH of backup heat.

DOMESTIC HOT WATER: Cold water supply is pumped through two rows of fin coil heat exchangers located in the air above storage. Preheated water is then taken to an 82 gallon preheat storage tank, linked to a second conventional 80 gallon hot water heater for house hot water supply.

COOLING: The heat pump can also be used for cooling assist.

MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW Preheat.



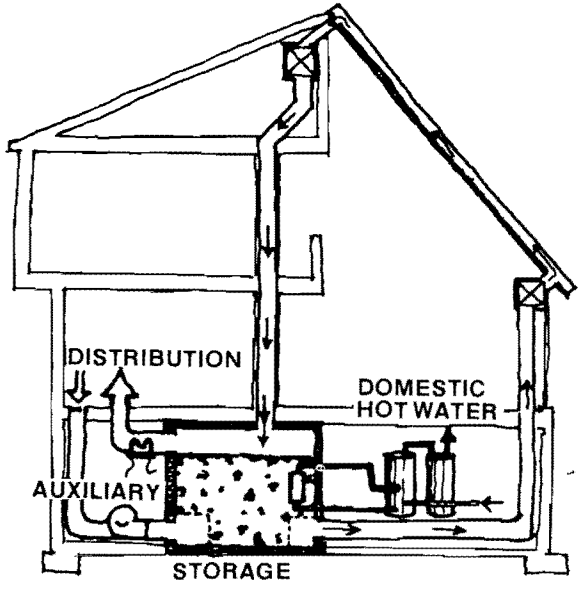


PROJECT INFORMATION:

BUILDER/APPLICANT: Fletcher Myers, Inc.
DESIGNER: Charles W. D. Myers
SOLAR SUB: Fletcher/Myers Contracting, Inc.
LOCATION: East Derry, NH — **LATITUDE:** 43°N
HOUSING TYPE: SFD, 1 Unit — **AREA:** 2,040 sq. ft.
CLIMATIC DATA:
HEATING DD: 7,612 — COOLING HRS:
DESIGN TEMP: WINTER: −10° F — SUMMER: 90° F
HORIZ. INSOL. JAN. DAY: 440 BTU/ft² — % SUN/YR: 57%

BUILDING DESCRIPTION/ENERGY CONCERNS

This single family home encompasses 2,040 sq. ft. of floor area and 3 bedrooms. Energy conservation features include orienting the house on the east-west axis so that the south face receives maximum exposure, and exposure to winds is minimized. South facing windows are of Thermopane, and double hung windows are PVC weather-stripped. 6" of insulation in the ceiling and floors, doors of solid core with PVC weatherstripping, sunscreens on the south face of house & shutters with interior insulation are added to help prevent heat loss.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 66.85%

COLLECTOR: 787 sq. ft. of corrugated flat plate air collectors are directly mounted to the roof on the south face at a 50° tilt. Built by the applicant, these collectors use air to transfer the sun's heat to rock storage.

STORAGE: Solar storage is 400 cu. ft. of gravel located in the basement. From here air is blown into the living space.

DISTRIBUTION: Forced hot air.

AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by electric resistance reheat coils placed in the ductwork at the distribution point. This also provides backup energy and has a capacity of 71,694 BTUH.

DOMESTIC HOT WATER: DHW is preheated in a heat transfer coil in solar storage and taken to a hot water preheat tank. Hot water is circulated to a conventional electrically heated hot water tank.

MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.

PROJECT INFORMATION:
BUILDER/APPLICANT: Houston Construction, Inc.
DESIGNER: John Weldt, Arch.
SOLAR SUB: Solar Dynamics, Inc.

BUILDER/APPLICANT: Design Construction Assoc.
DESIGNER: Michael Torgerson, Arch.
SOLAR SUB: Design Construction Assoc.
LOCATION: Bigfork, MT
HOUSING TYPE: SFD, 1 Unit
CLIMATIC DATA:
HEATING DD: 8,191
DESIGN TEMP: WINTER: −15° F
HORIZ. INSOL. JAN. DAY: 558 BTU/ft²

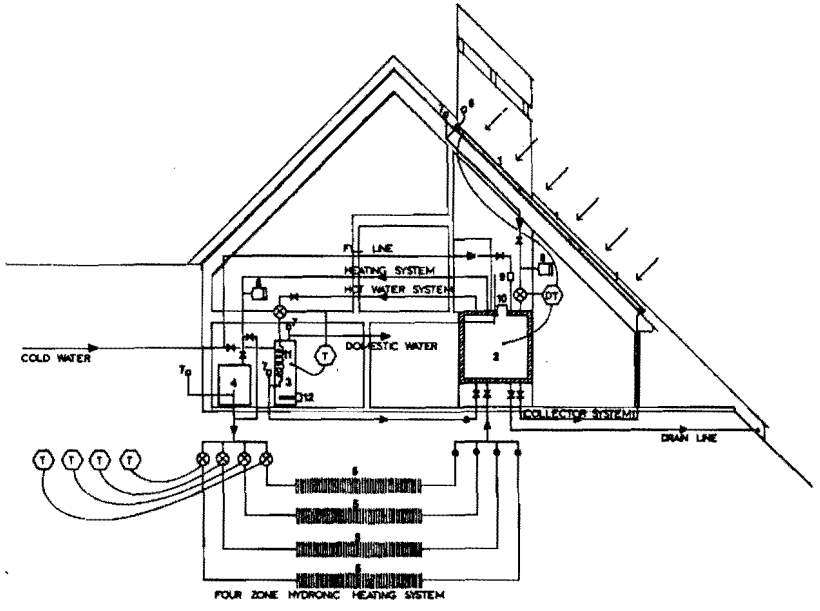
LATITUDE: 48°N
AREA:
COOLING HRS:
SUMMER:
% SUN/YR: 53%

BUILDING DESCRIPTION/ENERGY CONCERNS

This new 3-bedroom single family home has many passive design features. The whole building is set into a south facing slope using earth to prevent heat loss from winter winds. Heavy insulation is also used, as is insulating glass. The heat generated by the fireplace is retained in the solar storage tank. A skylight with an insulating shutter acts as a passive collector and holds in heat collected during the day.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 61%



COLLECTOR: 750 sq. ft. of Revere flat plate collector is mounted directly on the roof, at an angle of 45°, facing due south. Anti-freeze (ethylene glycol) is used to transport the heat from collector to storage.

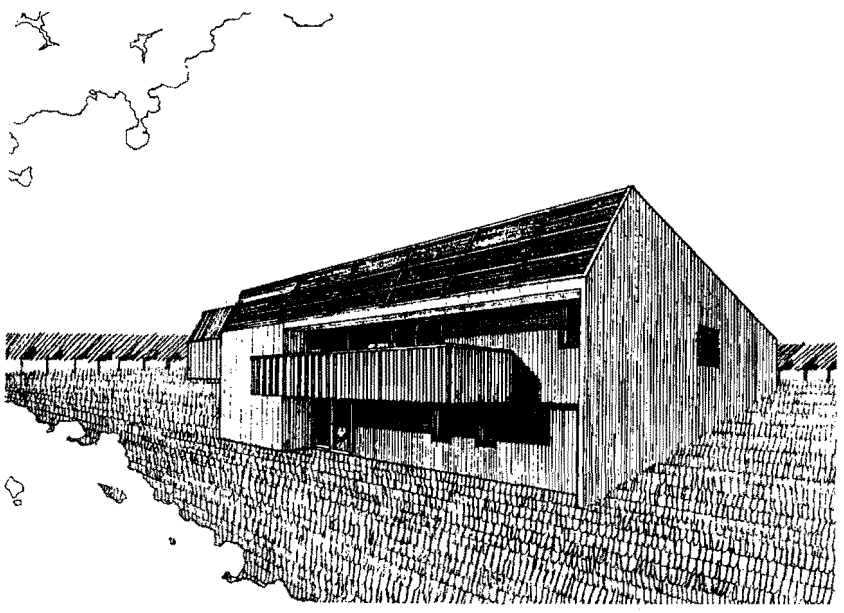
STORAGE: A 1,300 gallon storage tank is centrally located on the first floor. The heated liquid is pumped into baseboard units.

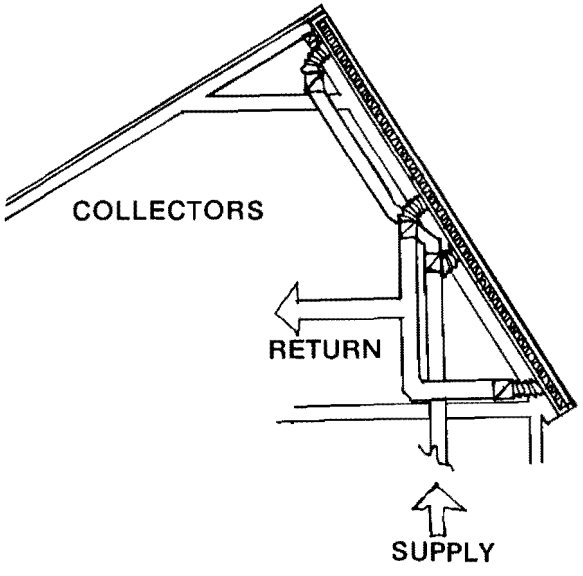
DISTRIBUTION: Hydronic baseboard units in 4 zones.

AUXILIARY ENERGY SYSTEM: The central fireplace with circulating air ducts can assist, while electric resistance coils with a capacity of 38,000 BTUH heat the storage liquid for backup heat distribution.

DOMESTIC HOT WATER: Hot liquid is taken from the top of the storage tank, to a heat exchange coil in the DHW heater, where it loses its heat to boost the temperature of the incoming cold water.

MODES OF OPERATION: Collector to storage, storage to house, auxiliary to house, DHW preheat.





FOR TYPICAL SOLARON HEATING SYSTEM, SEE PAGE 13

PROJECT INFORMATION:

BUILDER/APPLICANT: Houston Construction, Inc.
DESIGNER: John Weidt, Arch.
SOLAR SUB: Solar Dynamics, Inc.
LOCATION: Eden Prairie, MN
LATITUDE: 44°N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,796 sq. ft.
CLIMATIC DATA:
HEATING DD: 8,382
COOLING HRS:
DESIGN TEMP: WINTER: −10° F
SUMMER: 89° F
HORIZ. INSOL. JAN. DAY: 580 BTU/ft²
% SUN/YR: 50%

BUILDING DESCRIPTION/ENERGY CONCERNS

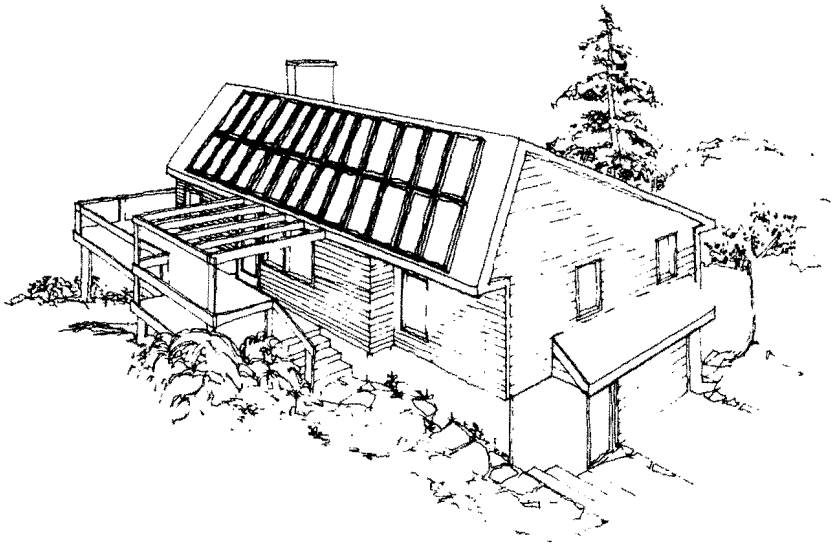
This single family house has 1,796 sq. ft. of floor area and 3 bedrooms. Situated in a cold but sunny climate, its energy conserving features include organizing the spaces so that occupied rooms face south with utility rooms acting as thermal insulation on the north side; and using a sloping site to maximize above ground wall area on the southern face and minimize northern wall area. Insulation has been increased to 12" in the attic and 6" batt in exterior walls. There is triple glazing in all windows and in patio doors, vestibules on all major entrances, and an insulated storage area between the house and the garage area on the northern side.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 61.5%

COLLECTOR: 468 sq. ft. or 24 panels of flat plate collectors are mounted integrally to the south facing roof slope at a 60° tilt. Manufactured by Solaron, these collectors use air to transfer the sun's heat to rock storage.
STORAGE: 234 cu. ft. of crushed rock in an insulated concrete bin is located in the mechanical room. From here, or directly from the collector, a central air handling unit blows solar heated air into the living space
DISTRIBUTION: Forced hot air.
AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by a gas fired conventional furnace with 50,000 BTUH capacity. This also acts as the back-up heating source.
DOMESTIC HOT WATER: City water is pumped through a preheat coil located in the collector-storage circuit, which heats the water on its way to an 80 gallon preheat tank. Hot water is then circulated to a 40 gallon conventional gas-fired hot water tank which acts as the auxiliary hot water heating system.
MODES OF OPERATION: Collector to house, collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.

BUILDER/APPLICANT: Gridley Construction Co.
DESIGNER: Roger Freeberg
SOLAR SUB: Solar Dynamics
LOCATION: Minneapolis, MN
LATITUDE: 45°N
HOUSING TYPE: SFD, 1 Unit
AREA: 2,080 sq. ft.
CLIMATIC DATA:
HEATING DD: 8,382
COOLING HRS:
DESIGN TEMP: WINTER: −10° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 530 BTU/ft²
% SUN/YR: 45%



BUILDING DESCRIPTION/ENERGY CONCERNS

This 2-story, 3-bedroom single family house has a minimum of exposed surfaces due to a very compact plan. For energy conservation, insulation has been increased to match the energy codes of the state, and few glass surfaces are exposed to the north and east. All windows are triple glazed against extensive heat loss or gain, and porch overhangs protect south and west windows from summer sun. Trees have been preserved for shading on the west, and as a windbreak on the north.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 44%

COLLECTOR: 468 sq. ft. of Solaron flat plate air collectors have been direct mounted on a south facing roof at a 55° tilt. Air is drawn through the collector to a Solaron air handling unit which distributes hot air directly to the house or to rock storage.

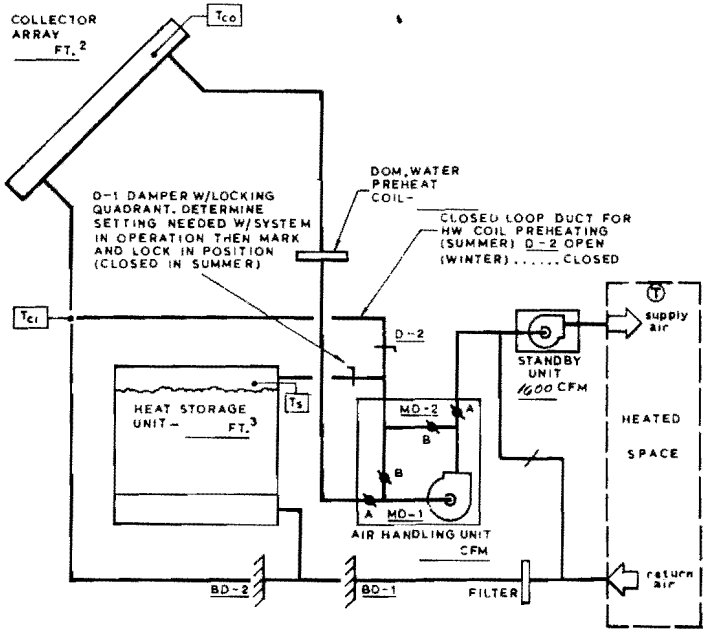
STORAGE: 240 cu. ft. of rock storage are contained in a concrete bin wrapped with 1½" of fiberboard.

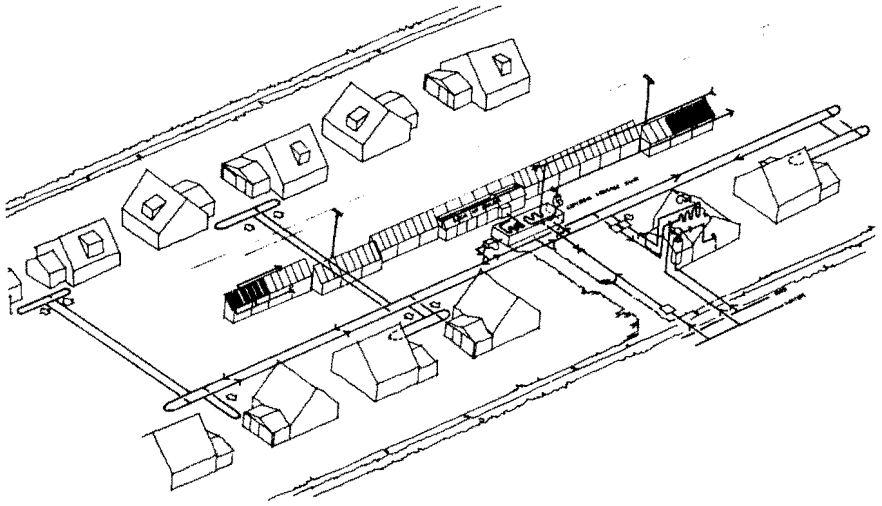
DISTRIBUTION: A fan in the Solaron air handling unit and one in a stand-by unit blows air through rock storage for a forced hot air distribution.

AUXILIARY ENERGY SYSTEM: An electrical heat pump with a 42,000 BTUH capacity acts as the backup heat source.

DOMESTIC HOT WATER: City water supply is drawn through a finned heat exchanger coil in the collector-storage duct, and is thus preheated before reaching the conventional DHW heater of 80 gallons.

MODES OF OPERATION: Collector to house, (via air handler), collector to storage (via air handler), storage to house (via air handler), auxiliary to house (via air handler), storage to auxiliary to house, DHW preheat.



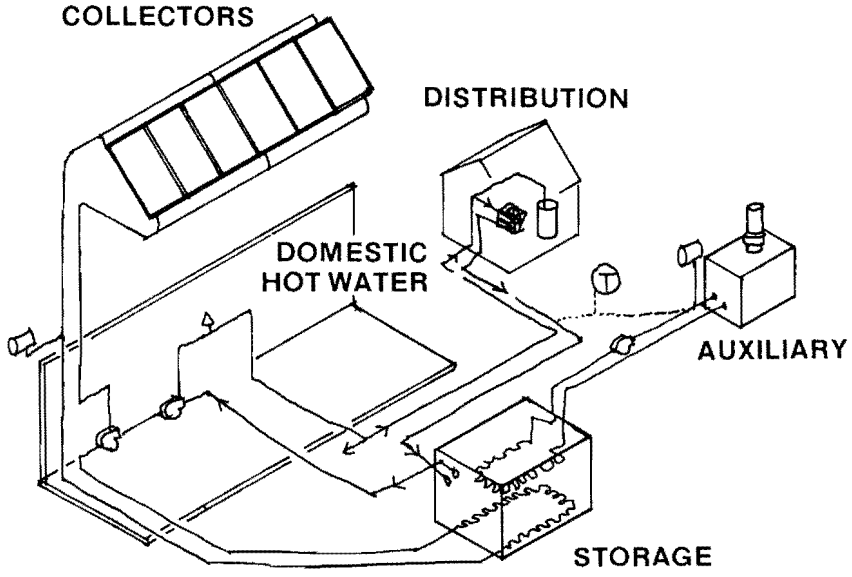


PROJECT INFORMATION:

BUILDER/APPLICANT: San Bernadino Community Dev.
DESIGNER: Earth/Life Systems Design
SOLAR SUB: Solarcoa, Inc.
LOCATION: San Bernadino, CA **LATITUDE:** 34°N
HOUSING TYPE: SFD, 10 Units **AREA:** 1,000 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 2,018 COOLING HRS: 1,188
DESIGN TEMP: WINTER: 31° F SUMMER: 101° F
HORIZ. INSOL. JAN. DAY: 1,010 BTU/ft² % SUN/YR: 65%

BUILDING DESCRIPTION/ENERGY CONCERNS

This grouping is composed of 10 existing single family homes with approximately 1,000 sq. ft. and 4 bedrooms each. The area has been retrofitted with a central solar heating and domestic hot water system which accommodates 10 homes. By building the collector and equipment sheds, with underground storage, in a shared central open space, a separation between houses is created, and more private open space at the rear of several houses is defined.

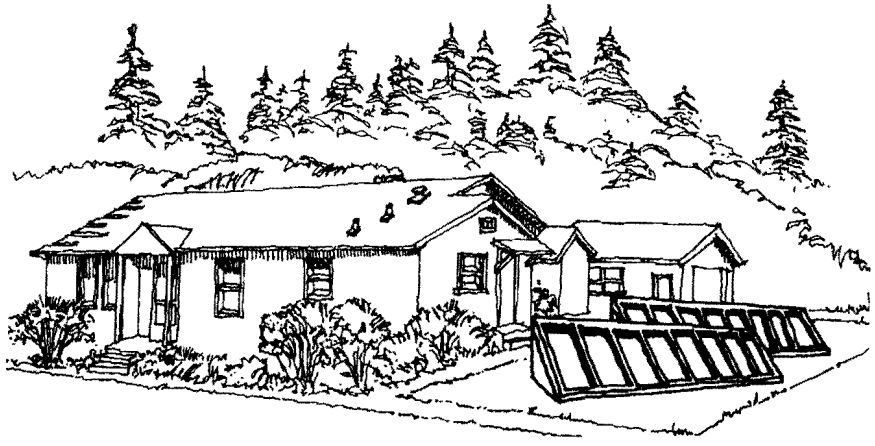


SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 73%

COLLECTOR: 2,000 sq. ft. of flat plate, liquid collectors are mounted on a free standing rack structure in the area between the houses. The collectors face due south and are tilted at 45°. The drain down method is used to prevent freezing in the circuit. Manufactured by Solarcoa, these collectors use water in a closed recirculating loop to transfer the sun's heat to water storage.
STORAGE: 5,000 gallons of water are located in an underground tank near the collectors. From here hot water is circulated in a hot water loop which connects to each house. Within the house, hot water travels through a fan coil unit which blows hot air into the space.
DISTRIBUTION: Forced air, with the hallway as the plenum.
AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by a central gas-fired boiler of 320,000 BTUH capacity located above the central solar storage. The 40 gallon DHW heater with 32,370 BTUH capacity located in each house can also circulate hot water to the fan coil unit. Finally, wall panel radiant heaters in each room with 25,000 BTUH capacity can also assist in heating.
DOMESTIC HOT WATER: DHW is provided directly from solar storage and circulated to a 40 gallon hot water tank.
MODES OF OPERATION: Collector to storage (closed loop), storage to house, storage to auxiliary to house, auxiliary to house (DHW heater), DHW preheat.

BUILDER/APPLICANT: *California Energy Resources*
DESIGNER: Conservation & Development Commission
SOLAR SUB: Office of the State Architect
LOCATION: Northern California
LATITUDE: 38°-41°N
HOUSING TYPE: Ranger Stations, 3 Units
AREA: 1,200 sq. ft. unit
CLIMATIC DATA:
HEATING DD: 4,251-7,520
COOLING HRS:
DESIGN TEMP: WINTER: −4° to 40° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 1,825 to 2,772 BTU/ft²
% SUN/YR: 47-73%

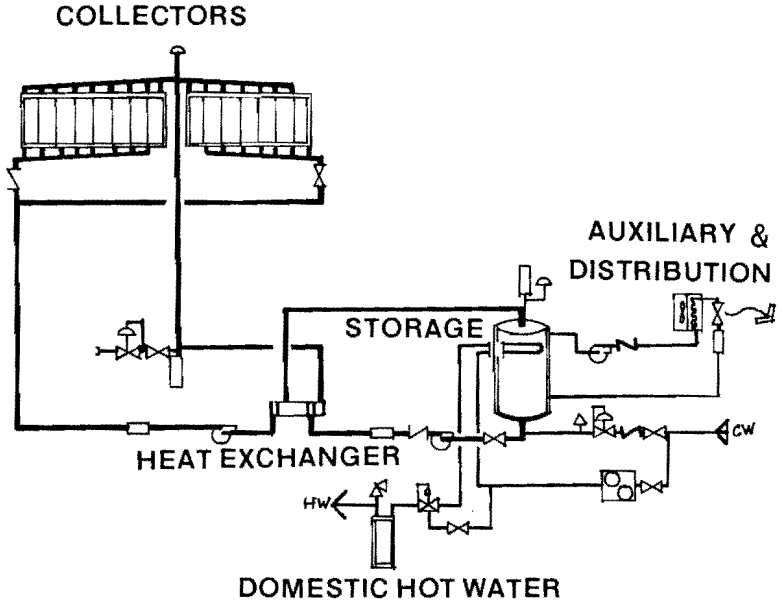


BUILDING DESCRIPTION/ENERGY CONCERNS

This project involves 3 existing ranger's homes in California state parks. They each have 2 bedrooms and cover 1,200 sq. ft. Some of the models feature earth berming on the north wall for wind resistance, and overhangs on the south side to shade window surfaces. Another energy conserving feature includes the placing of trees on east, west and north faces to shade summer sun, but not to interfere with the winter sun and southern exposed collectors.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 58%, 69%, 71%



COLLECTOR: The Chamberlain flat plate collectors range from 247-285 sq. ft., and two assemblies are mounted on the southwest and southeast facing roofs, while the third is rack-mounted next to the house. One uses an antifreeze/water mixture for transport, while the others use water. The system using antifreeze has a heat exchanger between collector and storage.

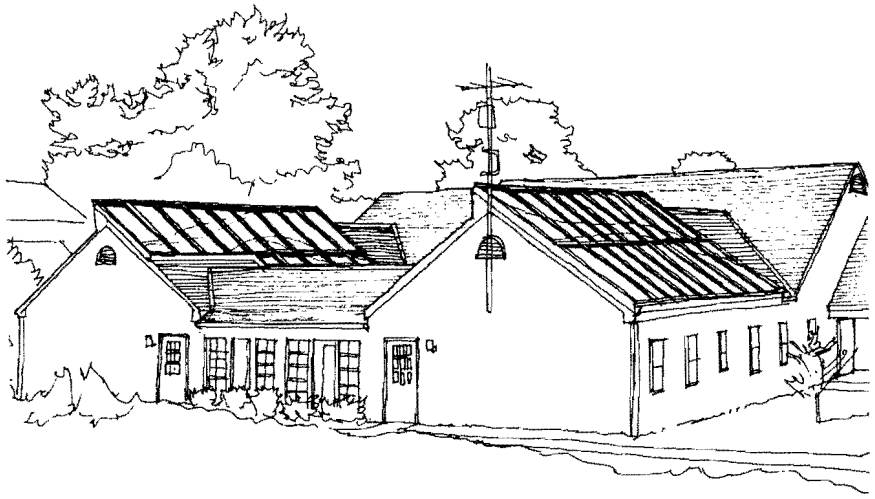
STORAGE: Each of the houses has a 530 gallon water storage tank located in a mechanical room adjacent to the house. The heated water is pumped to coils in an air distribution system.

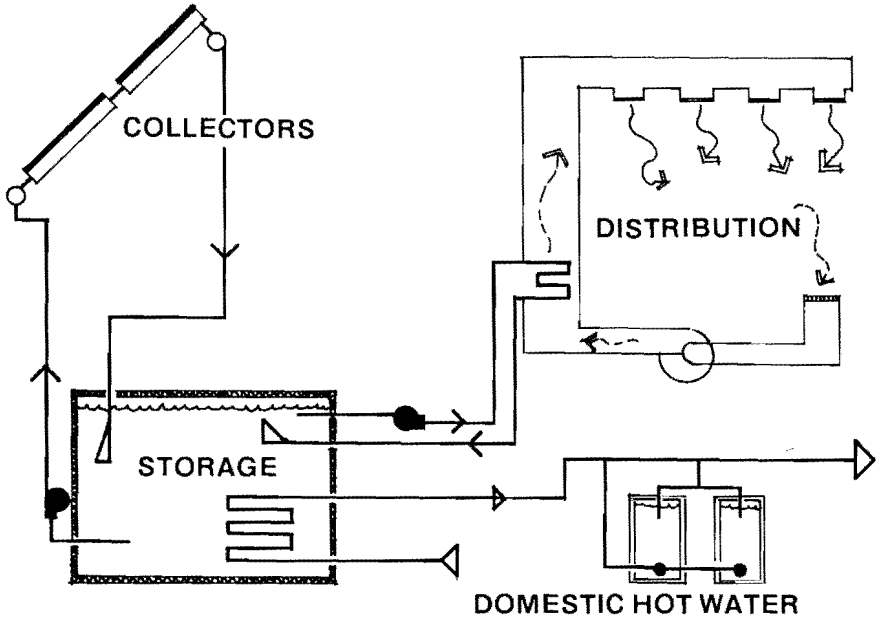
DISTRIBUTION: Two houses use local fan coils, the third uses a furnace with air ducts to supply heat to the house.

AUXILIARY ENERGY SYSTEM: Consequently, two houses use electric fan coil units with 30,000 BTUH capacity as auxiliary energy, while the third has an electric furnace with 80,000 BTUH capacity.

DOMESTIC HOT WATER: All three units route the incoming cold water through a loop in the storage tank for water preheat before it reaches the existing DHW tank.

MODES OF OPERATION: Collector to storage (via heat exchanger for antifreeze solution), storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.





PROJECT INFORMATION:
BUILDER/APPLICANT: Executive Office of Community Dev.
DESIGNER: Mass Design Arch. & Planners
SOLAR SUB: Sunsav Inc.
LOCATION: Northhampton, MA — **LATITUDE:** 42°N
HOUSING TYPE: SFD, 1 Unit — **AREA;** 2,000 sq. ft.
CLIMATIC DATA:
HEATING DD: 6,400 — COOLING HRS:
DESIGN TEMP: WINTER: −3° F — SUMMER: 85° F
HORIZ. INSOL. JAN. DAY: 429 BTU/ft² — % SUN/YR: 52%

BUILDING DESCRIPTION/ENERGY CONCERNS

This single family home includes 2,000 sq. ft. of floor area and 5 bedrooms. It functions as a cooperative handicapped residence and has been retrofitted with a solar energy heating and domestic hot water system.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION : 39%

COLLECTOR: 952 sq. ft. of flat plate, liquid collectors are directly mounted to an existing roof structure facing south at a 33° tilt. The drain down method is used to prevent freezing in the circuit. Manufactured by Sunsav, Inc., these collectors use water to transfer the sun's heat to water storage.

STORAGE: The water storage tank is made of concrete block with a vinyl liner, and is located in the basement. From here water is circulated to a fan-coil unit which blows air over the hot coils and into the living space.

DISTRIBUTION: Forced hot air distribution.

AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by existing electric baseboard heaters. The backup capacity of this system is 105,434 BTU.

DOMESTIC HOT WATER: City water is heated in a closed copper coil, suspended in the solar storage tank, and then carried to 2 existing hot water heaters of 240 gallons total capacity.

MODES OF OPERATION: Collector to storage, storage to space, auxiliary to space, DHW preheat.

ACTIVE HEATING & DHW 1 SFD RETROFIT 6400 DD MASSACHUSETTS

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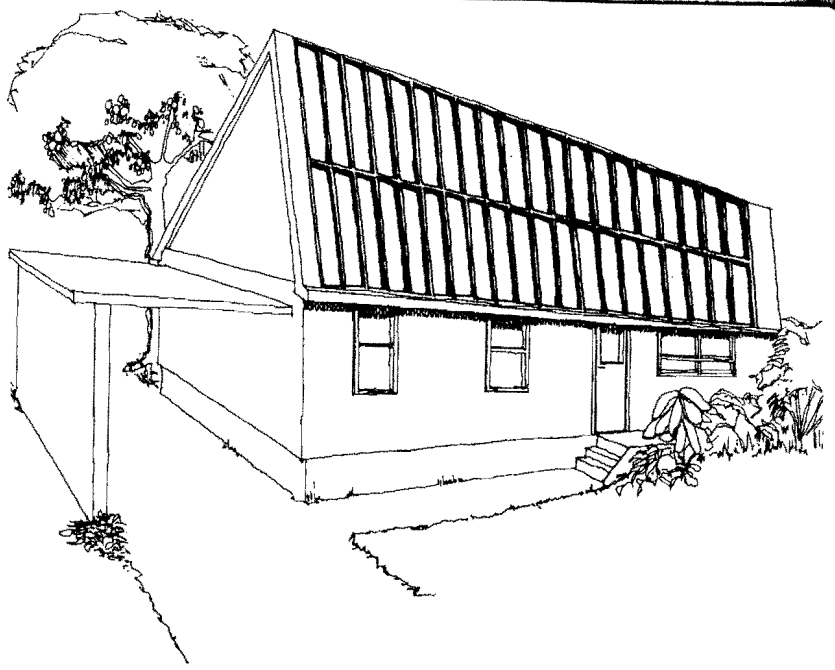
PROJECT INFORMATION:
BUILDER/APPLICANT: Pleasant Point Housing Authority
DESIGNER: Norman Laberge
SOLAR SUB: Environmental Energy Inc.
LOCATION: Perry, ME
LATITUDE: 44.9°N
HOUSING TYPE: SFD, 2 Units
AREA: 1,024, 1,312 sq. ft.
CLIMATIC DATA:
HEATING DD: 7,344
COOLING HRS:
DESIGN TEMP: WINTER: 7° F
SUMMER: 79° F
HORIZ. INSOL. JAN. DAY: 440 BTU/ft²
% SUN/YR: 51%



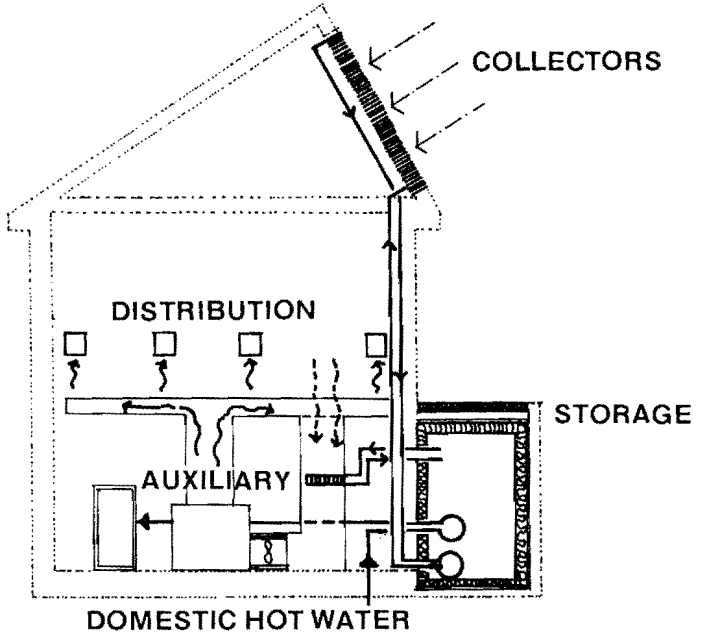
BUILDING DESCRIPTION/ENERGY CONCERNS

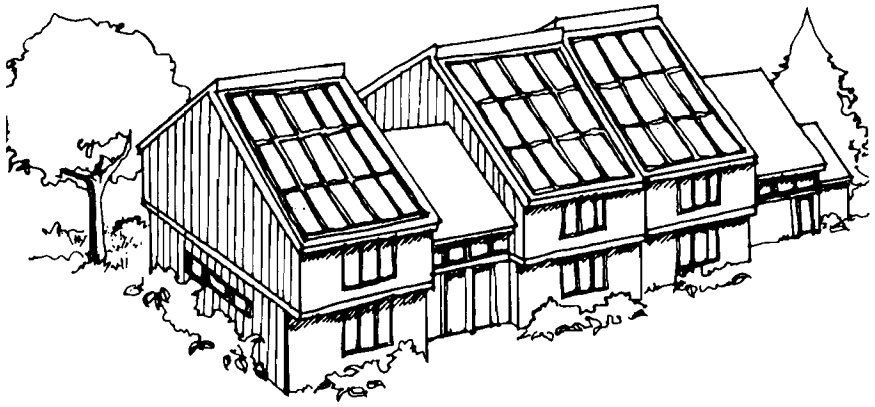
These 2 single family homes have 1,024 and 1,312 sq. ft. of floor area and 3 and 5 bedrooms, respectively. They have been retrofitted with solar heating and domestic hot water systems. Their energy conservation features include: good orientation, with the length of the house on the east-west axis so that the long face is exposed to the south; thermal efficiency, by massing the house compactly into a rectangular plan; and improved insulation: with 6" of glass fiber insulation in the ceiling compounded by roof insulation, 4" of foilback insulation in the walls, and the elimination of windows on the east and west faces.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 25%

COLLECTOR: 420 and 540 sq. ft. of flat plate, liquid collector is integrally mounted to the roof of each existing house, facing south at a 60° tilt. Manufactured by Sunworks, Inc., these collectors use a liquid solution of 50% water and 50% propylene glycol to prevent freezing in the circuit. This antifreeze liquid transfers solar heat through a heat exchanger to water storage.
STORAGE: 900 gallons of water storage is located in an 8" concrete tank with 1" insulation. It is located underground next to the basement wall. Storage water is circulated through coils over which ventilation air is blown into the space.
DISTRIBUTION: Forced hot air.
AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by an oil furnace which is located in the basement. With capacities of 84,000 or 100,000 BTUH respectively. This also serves as the backup system.
DOMESTIC HOT WATER: Preheated water is supplied to a 60 or 80 gallon hot water tank via a closed heat exchanger coil in solar storage. An electric resistance coil in the hot water tank acts as the auxiliary heating source.
MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.





PROJECT INFORMATION:

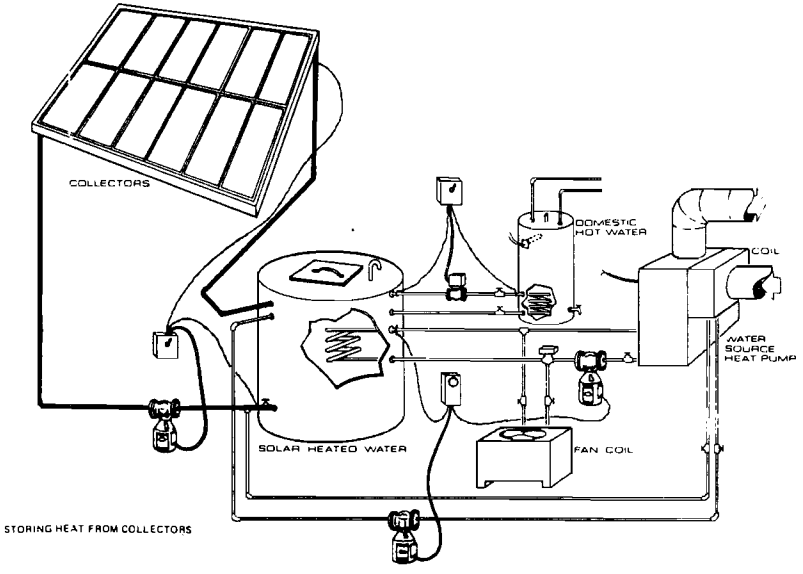
BUILDER/APPLICANT: Unified Development Inc.
DESIGNERS: James Buckley & Associates, Architects
Independent Living, Inc.
LOCATION: Swainsboro, GA
HOUSING TYPE: SFA, 3 Units
CLIMATIC DATA: HEATING DD: 2,200
DESIGN TEMP: WINTER: 20° F
HORIZ. INSOL. JAN. DAY: 2,102 BTU/ft²
LATITUDE: 33°N
AREA: 1,100-1,425 sq. ft.
COOLING HRS:
SUMMER: 90° F
% SUN/YR: 60%

BUILDING DESCRIPTION/ENERGY CONCERNS

This project involves 3 townhouse units varying from 1,100-1,425 sq. ft. in area with 2 or 3 bedrooms. A minimum area of glass faces east and west, preventing excessive early and late day heat gain, while overhangs provide shading for the southern face.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 75%



STORING HEAT FROM COLLECTORS

COLLECTOR: Revere Copper and Brass manufactured the 819 sq. ft. of flat plate collectors for these 3 units. Water carries the heat collected from the south facing 40° tilt roof collectors to storage.

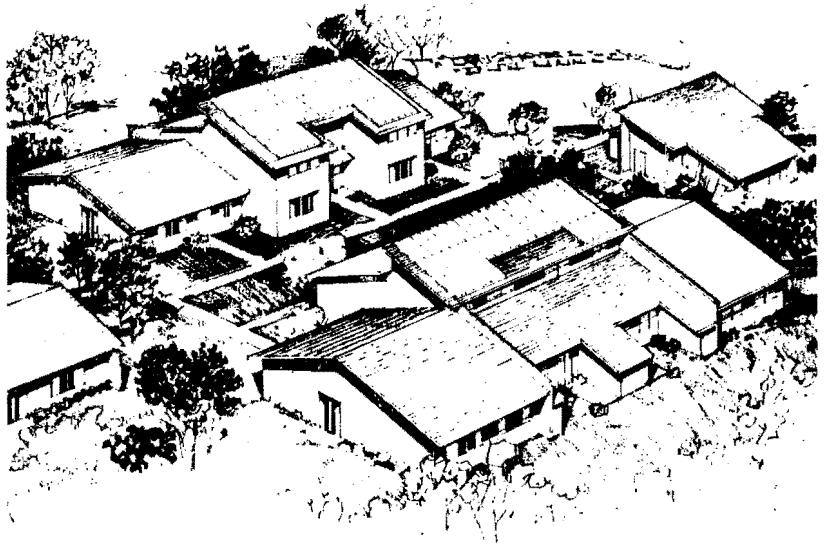
STORAGE: A 1,000 gallon steel water storage tank stores the collected heat for each unit. The tanks are buried adjacent to the town houses. The water is pumped to a coil in the return air duct of the forced hot air distribution system.

AUXILIARY ENERGY SYSTEM: A heat pump operates during off peak hours to provide heat to solar storage via a heat exchanger coil. The heat pump also supplies heat directly to the hot air furnace when necessary. Capacity is 20,000 BTUH.

DOMESTIC HOT WATER: Water from the top of storage is pumped through a heat exchanger in a 60 gallon hot water heater, to provide DHW preheat. An electric resistance coil provides DHW backup.

MODES OF OPERATION: Collector to storage, storage to house, auxiliary (heat pump) to storage, auxiliary (heat pump) to house, DHW preheat.

PROJECT INFORMATION:
BUILDER/APPLICANT: Phillips, Kauric, Adams & Branham
DESIGNER: William Bailey Kauric
SOLAR SUB: Walker Plumbing & Heating Co.
LOCATION: St. Matthews, SC
LATITUDE: 34°N
HOUSING TYPE: SFA, 12 Units
AREA: 580-1,262 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 2,484
COOLING HRS:
DESIGN TEMP: WINTER: 20° F
SUMMER: 98° F
HORIZ. INSOL. JAN. DAY: 910 BTU/ft²
% SUN/YR: 73%



BUILDING DESCRIPTION/ENERGY CONCERNS

These 12 units of single family attached homes include 4 different models encompassing 580 to 1,262 sq. ft. of space with 1 to 4 bedrooms. These houses conserve energy by having very few windows on the east and west faces. There are 3 central heating systems, one for each grouping of 4 housing units.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 75%

COLLECTOR: 640 to 832 sq. ft. of flat plate, double glazed liquid collector is integrally mounted to a shared roof structure, facing due south, and is tilted 20°. Manufactured by Revere, these collectors circulate warm water to prevent freezing in the circuit. Water is used to transfer the sun's heat to storage.

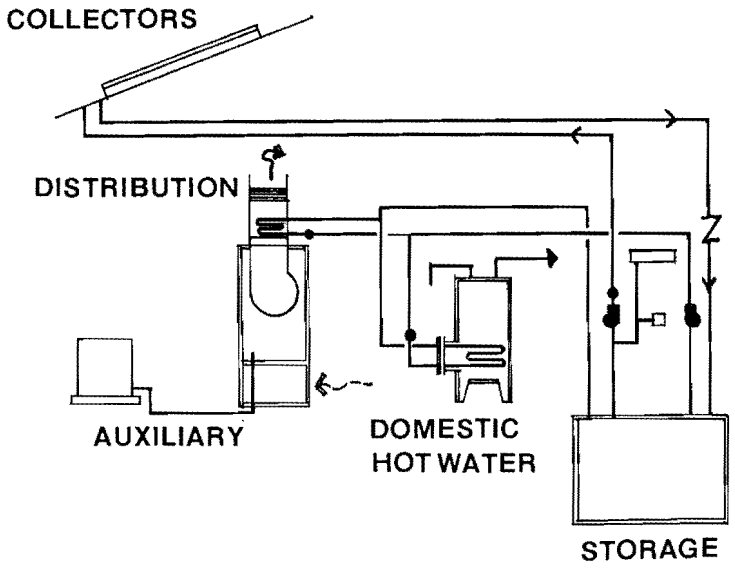
STORAGE: 750 to 1,500 gallons of water storage are located in an underground steel tank, insulated with 1½" glass fiber. From here the water is pumped to a coil in the ductwork over which air is blown for forced hot air space heating.

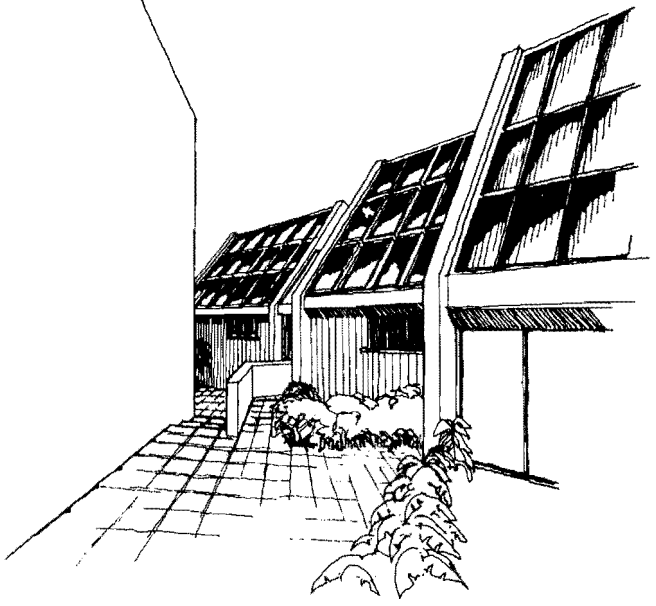
DISTRIBUTION: Forced hot air.

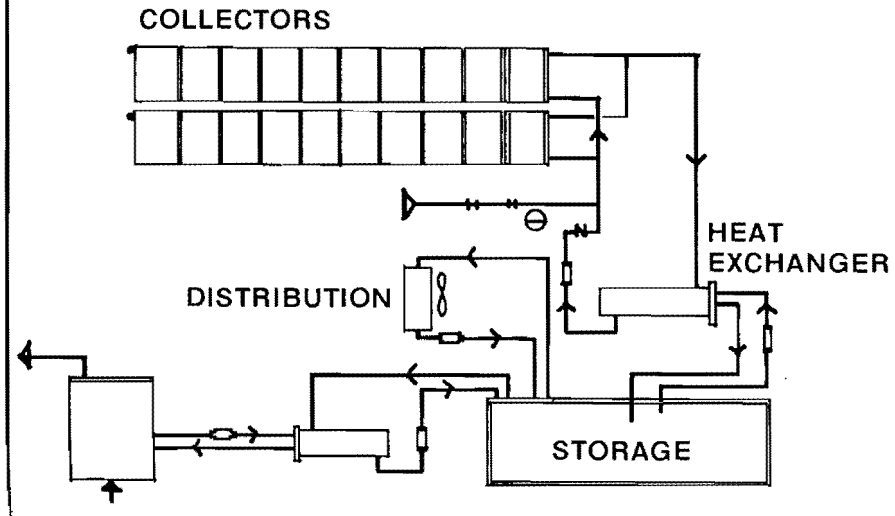
AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by an electric heat pump with a capacity of 25,500 and 20,400 BTUH. This also acts as the backup heating system.

DOMESTIC HOT WATER: A closed loop of hot water from solar storage heats DHW in a preheat tank of 40 or 80 gallon capacity. A second conventional electric DHW heater provides an auxiliary boost or backup energy.

MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.







PROJECT INFORMATION:
BUILDER/APPLICANT: Contemporary Import & Export Co.
DESIGNER: Joel H. Knanick
SOLAR SUB: United Plumbing, Inc.
LOCATION: Pittsburgh, PA
LATITUDE: 40°20'
HOUSING TYPE: SFA, 4 Units
AREA: 1,108 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 5,053
COOLING HRS:
DESIGN TEMP: WINTER: 7° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 510 BTU/ft²
% SUN/YR: 52%

BUILDING DESCRIPTION/ENERGY CONCERNS

These 4 townhouse units include 2 bedrooms each with 1,108 sq. ft. of space. Of wood frame construction, the buildings are given an open south and north exposure, with the east and west walls buffered by adjacent buildings or windowless. End units have staggered wall construction to allow north or south exposures for any additional windows desired. Southern walls and windows are set back under overhangs for shade protection.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 51%

COLLECTOR: 208 sq. ft. of flat plate fluid collectors have been rack mounted at a 60° tilt facing south. These Daystar collectors include a heat dump panel, and use a 60% glycerol antifreeze to carry heat from the collectors to a shell and tube heat exchanger.

STORAGE: Pumped through a closed loop in the solar heat exchanger water is heated and carried to three cylindrical 500 gallon storage tanks placed under the court between the units, and wrapped with 2-3" urethane foam.

DISTRIBUTION: Hot water is drawn from storage to a water-to-air coil in the forced air distribution system of each unit.

AUXILIARY ENERGY SYSTEM: A conventional boiler supplies heated water for the hydronic distribution.

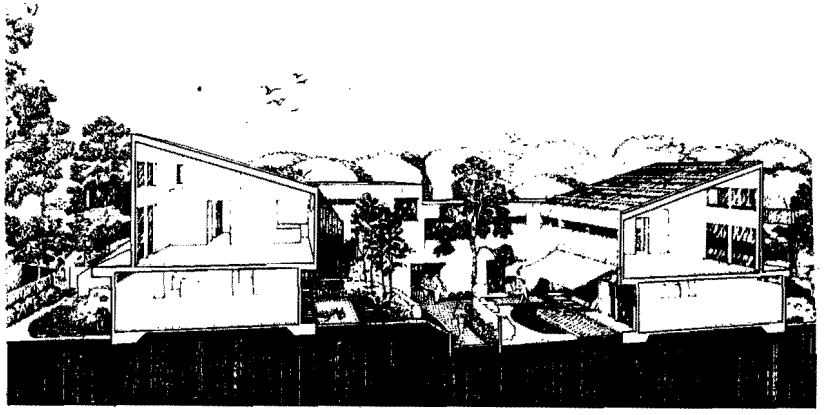
DOMESTIC HOT WATER: Hot water is also drawn from storage into a second shell and tube heat exchanger to preheat city water supply while preventing toxic contamination. Preheated water is then supplied to the conventional 80 gallon DHW heaters in each unit.

MODES OF OPERATION: Collector to house (via heat exchanger), collector to storage (via heat exchanger), storage to house, DHW preheat, auxiliary to house.

PROJECT INFORMATION:
BUILDER/APPLICANT: D. W. S. Holdings
DESIGNER: Pomeroy, Lebduska Associates
SOLAR SUB: Ecosol, Ltd.
LOCATION: Bedford, NY
LATITUDE: 41°15'N
HOUSING TYPE: SFA, 6 Units
AREA: 946-1,464 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 5,219
COOLING HRS: 1,000
DESIGN TEMP: WINTER: 1° F
SUMMER: 90° F
HORIZ. INSOL. JAN. DAY: 490 BTU/ft²
% SUN/YR: 60%

BUILDING DESCRIPTION/ENERGY CONCERNS

This project of 6 single family attached units includes 2 units each of 1, 2 and 3 bedroom houses with 946, 1,218, and 1,464 sq. ft. respectively. Energy conserving features include 1" insulating glass for sliding doors, wood casement windows, with awnings and venetian blinds added for shading.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 60%

COLLECTORS: 1,440 total sq. ft. of KTA Corp. concentrating tubular collectors have been rack mounted at a 20° tilt facing 20° east of south. Water is used as the heat transfer medium.

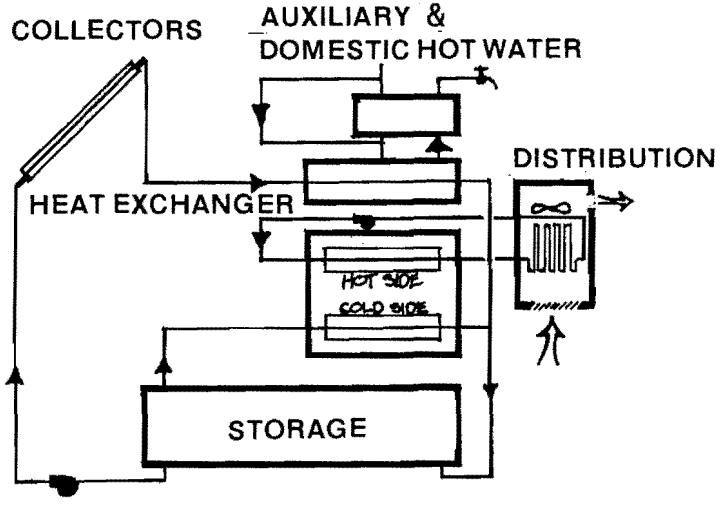
STORAGE: 6-1,000 gallon concrete tanks have been buried in the ground with 6" of sprayed insulation.

DISTRIBUTION: Hot water from storage is used in a coil heat exchanger to preheat the air in a forced hot air distribution system.

AUXILIARY ENERGY SYSTEM: An oversized electric DHW tank supplies the auxiliary hot water for the heat pump providing backup energy. The auxiliary electric water tank can also provide savings by loading during off-peak hours.

DOMESTIC HOT WATER: A double wall heat exchanger allows city water to preheat in copper coils wrapping the pipe containing the solar system's heated water. 80 gallon DHW heaters, with electric resistance elements, act as auxiliary and backup.

MODES OF OPERATION: Collector to house via heat pump, collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.



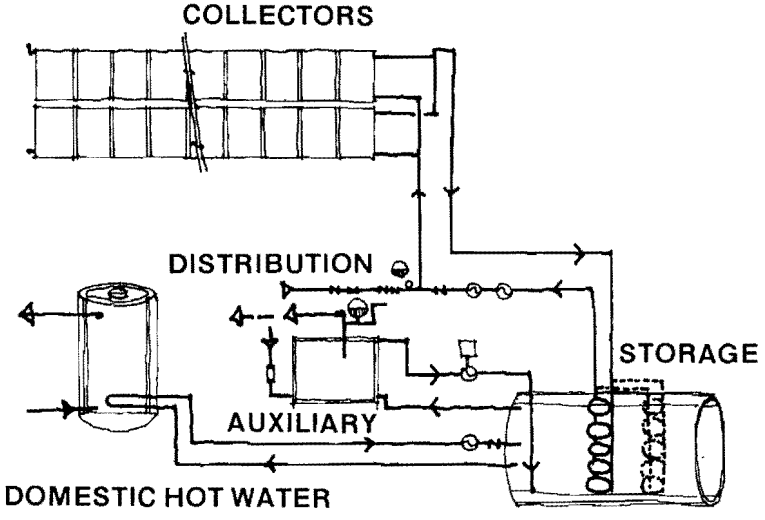
PROJECT INFORMATION:
BUILDER/APPLICANT: Town of Marion
DESIGNER: Town of Marion
SOLAR SUB: Sippican Solar Systems
LOCATION: Marion, MA
HOUSING TYPE: SFA, 12 Units
CLIMATIC DATA:
HEATING DD: 5,891
DESIGN TEMP: WINTER: 9° F
HORIZ. INSOL. JAN. DAY: 477 BTU/ft²

LATITUDE: 41°40'
AREA: 800 sq. ft.

COOLING HRS:
SUMMER: 84° F
% SUN/YR: 57%

BUILDING DESCRIPTION/ENERGY CONCERNS

These 6 duplex units, which comprise new housing for the elderly, encompass 800 sq. ft. of space per unit. Site modifications include a selective removal of trees, with north coniferous trees remaining to shield from northerly winds, while south trees, which would shade the collectors have been removed. Perimeter insulation of the floor slab has been added with generally increased insulation in the building envelope. Window area has been reduced; weatherstripping, storm doors and storm windows have been added.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 53.6%

COLLECTOR: 332.8 sq. ft. of flat plate, single glazed liquid collectors are rack mounted to the roof of each duplex, facing due south at a 60° tilt. Manufactured by the Daystar Corp., these collectors use a 60% glycol, 40% water solution to prevent freezing in the circuit. The collectors use this liquid to transfer the sun's heat through a heat exchanger to liquid storage.
STORAGE: 1,000 gallons of liquid storage is located underground outside the duplexes in a steel tank with 2-3" of urethane insulation. From here the liquid is circulated to the boiler, which can assist in heating.
DISTRIBUTION: Hydronic distribution system.
AUXILIARY ENERGY SYSTEM: Solar heating assist is supplied by an oil-fired boiler with a capacity of 86,000 BTUH. The boiler can also act as the backup system.
DOMESTIC HOT WATER: DHW is preheated in a finned copper heat exchange coil coming from solar storage to an 80 gallon hot water tank. This DHW tank, with an electric resistance boost, is located in a utility room common to both units in each duplex.
MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.

ACTIVE HEATING & DHW 12 SFA NEW 5891 MASSACHUSETTS

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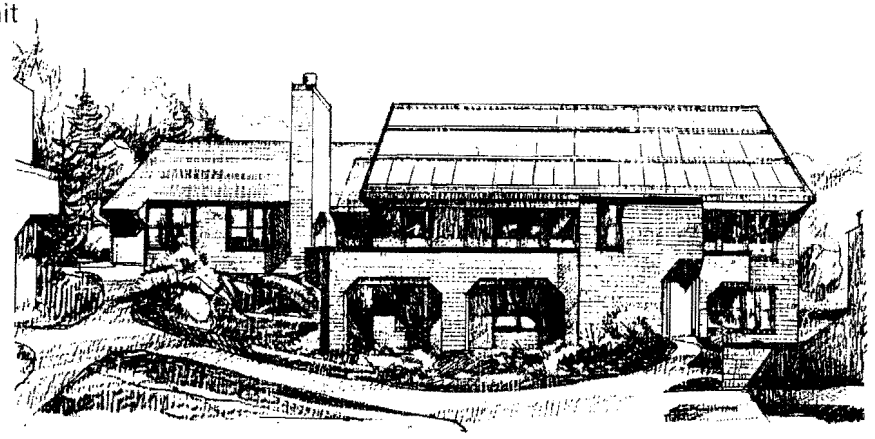
PROJECT INFORMATION:
BUILDER/APPLICANT: J. Capone Construction Co.
DESIGNER: Frank Chapman
SOLAR SUB: Kem Associates
LOCATION: Cheshire, CT
LATITUDE: 41°N
HOUSING TYPE: SFA, 10 Units
AREA: 464-601 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 5,897
COOLING HRS:
DESIGN TEMP: WINTER: 0° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 550 BTU/ft²
% SUN/YR: 56%



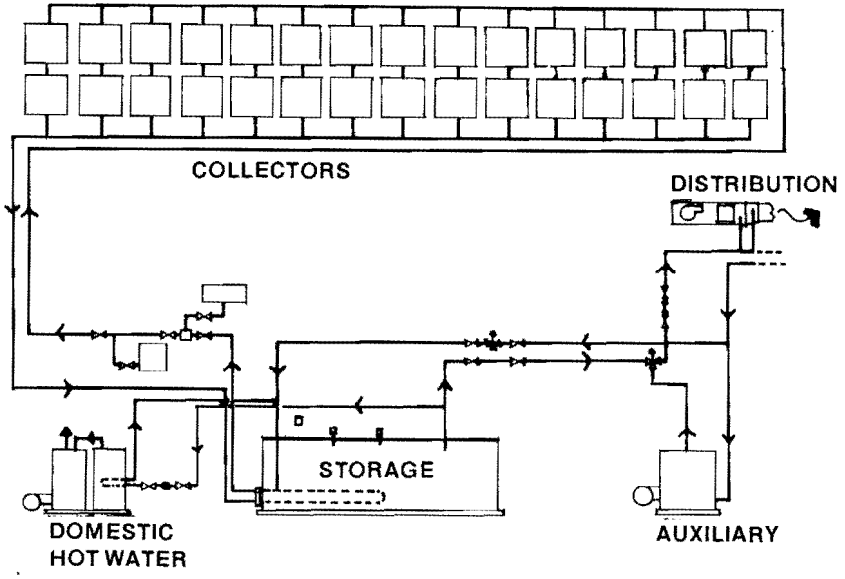
BUILDING DESCRIPTION/ENERGY CONCERNS

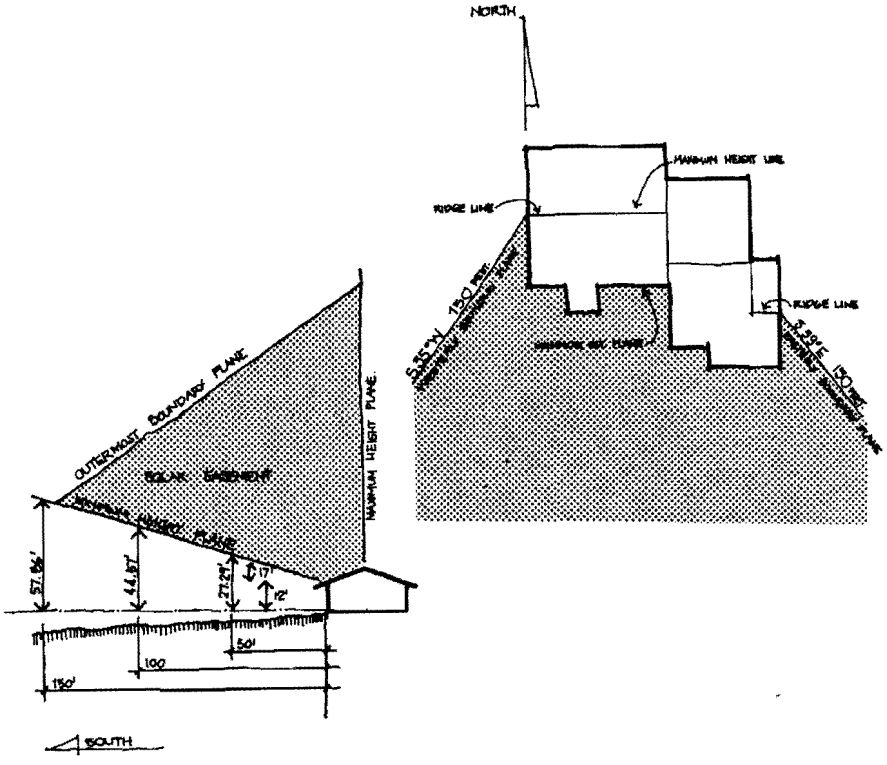
These 10 single family attached units encompass 464 to 601 sq. ft. of space and are efficiency and one bedroom units. Energy conservation features include orienting the length of the buildings on the east-west axis to allow maximum southern exposure. The 10 units are organized on a slope to minimize the north wall, and insulate the living spaces. The roofs are steep and offer wind protection. There is 13" of ceiling insulation and vents for cross ventilation. Against the winter climate, entrances are oriented south, windows are triple glazed (double and storm), while the use of arcades, overhangs and balconies provide summer shading.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 59%

COLLECTOR: 1,260 sq. ft. of flat plate, liquid collectors are directly mounted to the collective roof, facing due south at a 50° tilt. Manufactured by Sunworks, these collectors use 80% glycol and 20% water as their heat transfer media to prevent freezing in the circuit. This liquid transfers the sun's heat through a heat exchanger in water storage.
STORAGE: 5,020 gallons of water are located centrally to all the units in a steel enclosure with 6" of polyurethane insulation. From here water is circulated to a fan coil unit over which air is blown into the space.
DISTRIBUTION: Forced hot air.
AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by an oil-fired boiler with a capacity of 150,000 BTUH.
DOMESTIC HOT WATER: DHW is provided by a closed heat exchange coil coming from solar storage and immersed in a 120 gallon preheat tank. Hot water is then circulated to a central 200 gallon oil-fired domestic hot water tank, which acts as the auxiliary heat source.
MODES OF OPERATION: Collector to storage, storage to house, auxiliary to house, DHW preheat.





FOR TYPICAL SOLARON HEATING SYSTEM, SEE PAGE 13

PROJECT INFORMATION:

BUILDER/APPLICANT: Wonderland Hill Development Co.
DESIGNER: Downing Leach & Assoc.
SOLAR SUB: Solaron Corp.
LOCATION: Boulder, CO
LATITUDE: 40°N
HOUSING TYPE: SFA, 35 Units
AREA: 1,000-1,571 sq. ft.
CLIMATIC DATA:
HEATING DD: 6,103
COOLING HRS:
DESIGN TEMP: WINTER: 0° F
SUMMER: 92° F
HORIZ. INSOL. JAN. DAY: 910 BTU/ft²
% SUN/YR: 70%

BUILDING DESCRIPTION/ENERGY CONCERNS

35 single family townhouse units (7 buildings of 5 units each) have been individually designed with 2 to 3 bedrooms and 1,000 to 1,570 sq. ft. First, careful consideration of solar easement was made in building placement. Energy concerns include orienting window walls to the south and southwest and using townhouse massing to eliminate troublesome east and west exposures. 2 x 6 stud walls with extra insulation, tighter joint construction, double glazing and double air lock entries are included. Some units also use earth berming and greenhouses for further thermal optimization.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 35.2-48%

COLLECTOR: Depending on the unit size, 156 or 312 sq. ft. of flat plate air collectors have been directly mounted to a 23° sloped roof. Manufactured by Solaron, the collectors use air as the heat transport medium.
STORAGE: A central air handling unit blows the heated air to a rock storage, of 78,146, or 153 cu. ft. of riverbed rock. 1½" of rigid insulation surrounds the concrete storage bin.
DISTRIBUTION: The central air handler can also blow collector heat directly to the house, bypassing storage, or reverse the direction of flow to draw heat from storage for hot air distribution.
AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by an electric furnace in line with the central air handler, providing up to 51,000 BTUH of backup energy.
DOMESTIC HOT WATER: Cold water supply is preheated in a coil located in the collector return air duct and taken to a preheat storage tank of 80 gallons. A conventional 40, 60, or 80 DHW heater acts as auxiliary energy.
MODES OF OPERATION: Collector to house (via air handler), collector to storage (via air handler), storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.

PROJECT INFORMATION:
BUILDER/APPLICANT: Kearsarge Building Co., Inc.
DESIGNER: Ben Fishstein, Architect
SOLAR SUB: CT&L Corp.
LOCATION: North Conway, NH
LATITUDE: 44°N
HOUSING TYPE: SFA, 5 Units
AREA: 1,360 sq. ft.
CLIMATIC DATA:
HEATING DD: 7,383
COOLING HRS:
DESIGN TEMP: WINTER: 0° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 432 BTU/ft²
% SUN/YR: 54%

BUILDING DESCRIPTION/PASSIVE DESIGN CONCERNS

These 2 bedroom single family attached units are set into a south facing slope, minimizing heat loss from northerly winds. The south face of the units are set back under a horizontally slatted overhang. The fireplace can be used to heat all levels of the homes. There are 5 units of 1,360 sq. ft. each.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 46%

COLLECTOR: The flat plate collectors are located on the Daystar roof facing due south at an angle of 57°. They cover an area of 180 sq. ft. per unit. The liquid which takes the heat to water storage is a mixture of 60% glycerol (antifreeze) and 40% water.

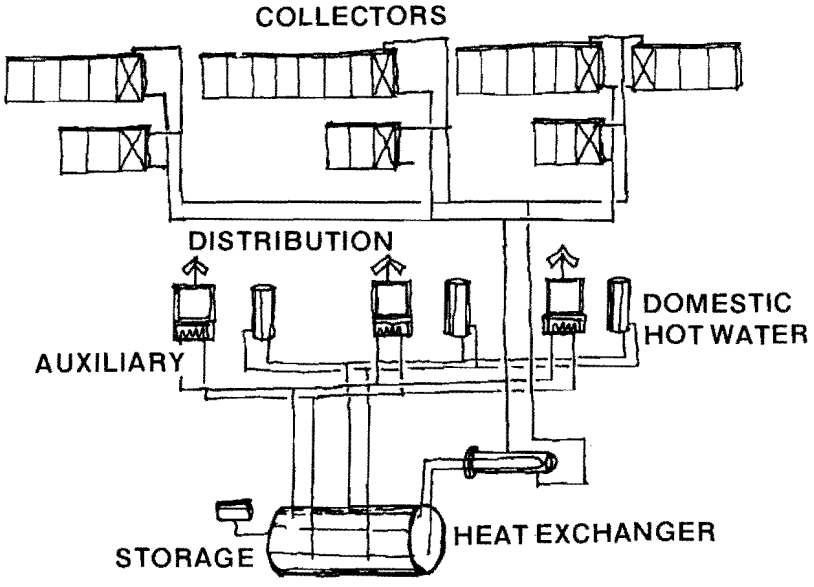
STORAGE: Solar heat is transferred to water in the storage circuit by a shell and tube heat exchanger. The heated water is stored in a 1,500 gallon steel tank in the basement. The water is pumped to a coil in the return air duct of the distribution circuit.

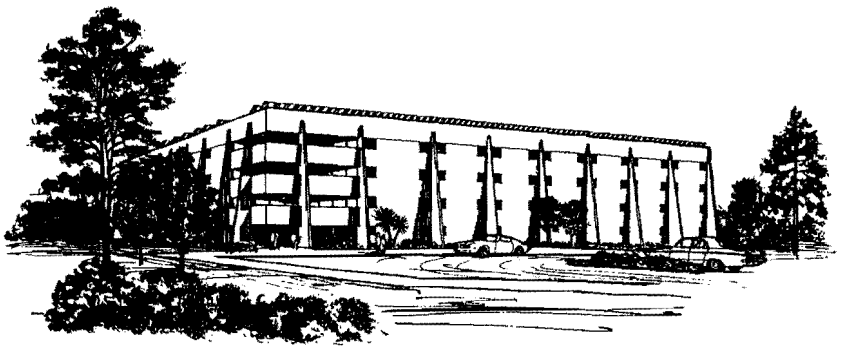
DISTRIBUTION: Forced hot air.

AUXILIARY ENERGY SYSTEM: A gas furnace supplies auxiliary heat.

DOMESTIC HOT WATER: A double heat exchanger between storage and distribution preheats city water before it enters an 80 gallon conventional DHW tank.

MODES OF OPERATION: Collector to storage (via heat exchanger), storage to house, auxiliary to house, DHW preheat.

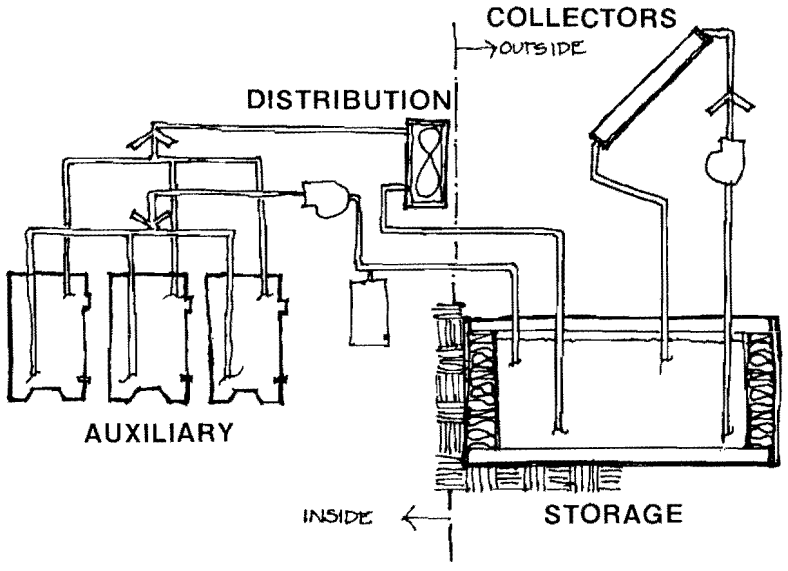




PROJECT INFORMATION:
BUILDER/APPLICANT: Albuquerque Western Solar Industries
DESIGNER: Burns & Peters/Architects
SOLAR SUB: Albuquerque Western Solar Industries Inc.
LOCATION: Albuquerque, N.M. **LATITUDE:** 35°N
HOUSING TYPE: MF Mid, 101 Units **AREA:** 630 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 4,383 COOLING HRS:
DESIGN TEMP: WINTER: 10° F SUMMER: 100° F
HORIZ. INSOL. JAN. DAY: 1,120 BTU/ft² % SUN/YR: 76%

BUILDING DESCRIPTION/PASSIVE DESIGN CONCERNS

This 5 story apartment building provides 101 units of housing for the elderly and handicapped. The building is oriented for maximum winter sun exposure, with vertical shading devices to reduce early and late day glare, and summer heat gains.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 50%

COLLECTOR: These parabolic trough collectors, which track the sun, are custom built and rack mounted on the roof. They cover a total of 8,000 sq. ft. Water is used to transport the collected heat to storage.

STORAGE: A 57,000 gallon water tank serves as solar storage, connected by an open circulation loop to the collectors. The heated water is pumped to the auxiliary boilers, then to fan coils in the individual apartments.

DISTRIBUTION: Fan coil units in each apartment blow air across hot water coils for hot air distribution.

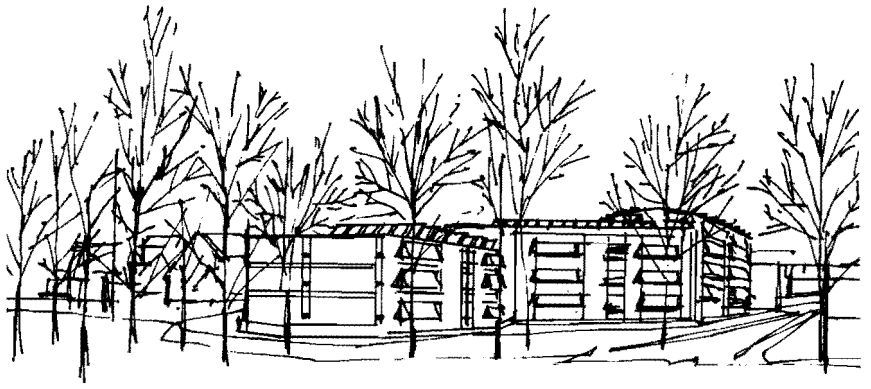
AUXILIARY ENERGY SYSTEM: Gas boilers with a 2,800,000 BTU capacity are used to supply auxiliary hot water to the fan coil units.

DOMESTIC HOT WATER: Domestic hot water is supplied by a completely separate solar system. Water is drawn from a 2000 gallon solar storage, heated in the DHW collectors, and transported through a shell and tube heat exchanger before returning to storage. Incoming city water supply is then preheated in the heat exchanger before being piped to the living units. A gas-fired boiler serves as backup to this city water circulation.

MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.

PROJECT INFORMATION:

BUILDER/APPLICANT: Creek Associates
DESIGNER: The Architectural Alliance
SOLAR SUB: Honeywell Solar Energy Systems
LOCATION: Minneapolis, MN **LATITUDE:** 44°N
HOUSING TYPE: MF Midrise, 77 Units **AREA:** 982 sq. ft. unit
CLIMATIC DATA:
HEATING DD: 8,382 COOLING HRS:
DESIGN TEMP: WINTER: −10° F SUMMER: 89° F
HORIZ. INSOL. JAN. DAY: 580 BTU/ft² % SUN/YR: 56%

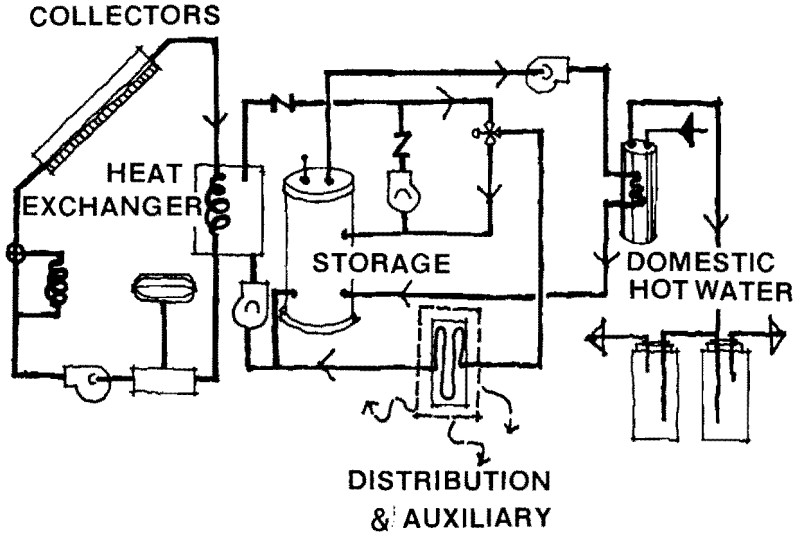


BUILDING DESCRIPTION/ENERGY CONCERNS

This project involves a 3 to 5 story mid-rise building of 77 apartment units. Solar energy is used to heat the corridor spaces and to heat the domestic hot water for the units. Energy conserving features include: awnings over windows on the east, south and west sides to shade from the summer sun; and berming on the north and west side to aid in insulating the building.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 28.17%



COLLECTOR: 6,048 sq. ft. of Honeywell flat plate collectors are rack mounted on the roof at a 45° angle facing due south. A 50/50 mixture of antifreeze and water passes through the collector to a shell and tube heat exchanger which transfers the collected heat to the storage circuit.

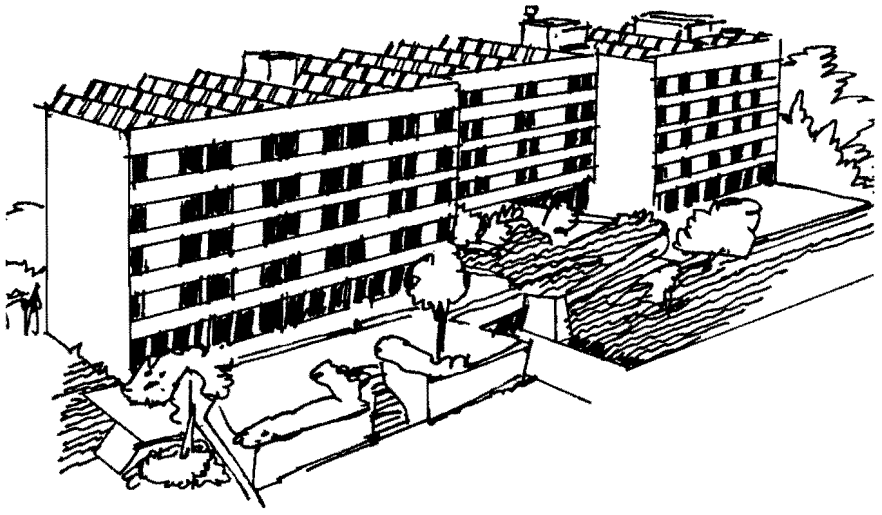
STORAGE: A 7,000 gallon water tank located in the basement stores the collected heat. The hot water is pumped through a coil in the air duct for hot air distribution.

DISTRIBUTION: Forced hot air.

AUXILIARY ENERGY SYSTEM: A gas-fired furnace with a capacity of 690,000 BTUH provides auxiliary heat.

DOMESTIC HOT WATER: Incoming city water enters a tank that is heated by a tube bundle heat exchanger connected to storage. The water is preheated in this 500 gallon tank before entering the conventional DHW heaters.

MODES OF OPERATION: Collector to storage (via heat exchanger), collector to house (via heat exchanger), storage to house, auxiliary to house, DHW preheat.



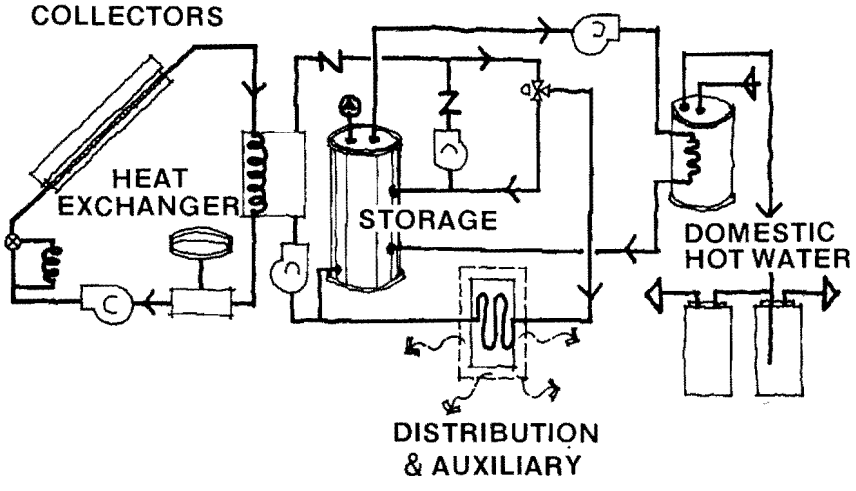
PROJECT INFORMATION:
BUILDER/APPLICANT: University of Colorado
DESIGNER: McFall & Konkel, Engineers
SOLAR SUB: Honeywell Energy Systems Center
LOCATION: Boulder, CO — **LATITUDE:** 40°N
HOUSING TYPE: MF Mid, 95 Units — **AREA:** 58,600 sq. ft. total
CLIMATIC DATA:
HEATING DD: 6,283 — COOLING HRS:
DESIGN TEMP: WINTER: 8° F — SUMMER:
HORIZ. INSOL. JAN. DAY: 910 BTU/ft² — % SUN/YR: 67%

BUILDING DESCRIPTION/ENERGY CONCERNS

This 5-story apartment building contains 58,600 sq. ft. of space and 95 apartments. An existing midrise, no changes have been made with the addition of the solar system.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 48.1%



COLLECTOR: 3,780 sq. ft. of liquid flat plate collectors have been rack mounted at a 45° tilt facing south on the flat roof of this multi-family midrise apartment building. Manufactured by Lennox Industries, these collectors use an antifreeze solution to transport heat from the collectors to a central heat exchanger.

STORAGE: 5,000 gallons of water storage are located in a steel tank, set in 6" of loose mineral wool. Water from storage is heated in the shell part of the heat exchanger and returned to the top part of storage, or pumped directly to the heating coil in the airduct.

DISTRIBUTION: A forced air distribution system has been added to, not combined with, the existing baseboard hot water coils and outside air system.

AUXILIARY ENERGY SYSTEM: A gas-fired boiler provides auxiliary energy to coils in the air duct distribution.

DOMESTIC HOT WATER: A closed loop from solar storage is taken through a 500 gallon hot water preheat tank. Preheated water is supplied to two conventional DHW heaters.

MODES OF OPERATION: Collector to house (via heat exchanger), storage to house, auxiliary to house, DHW preheat.

FLORIDA

766 DD

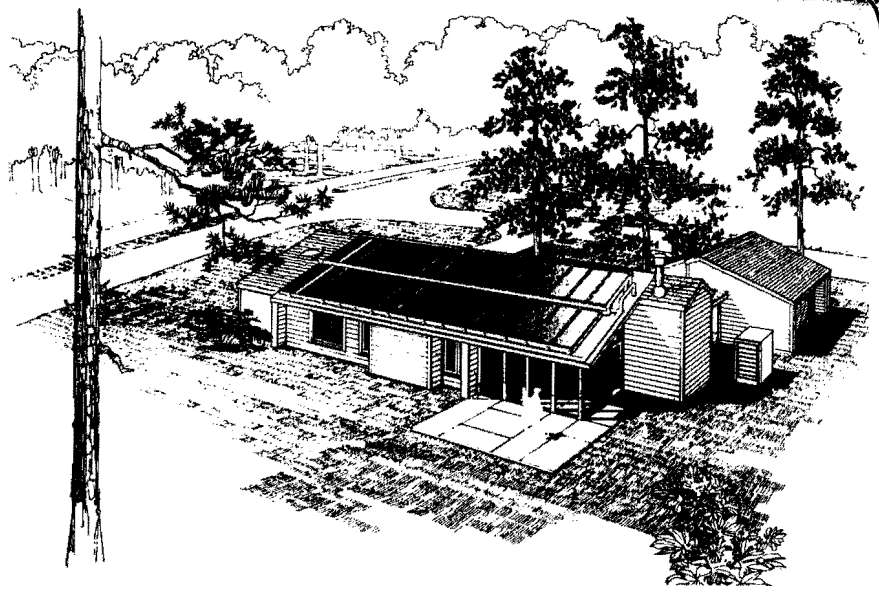
1 SFD NEW

ACTIVE H, C, & DHW

50

PROJECT INFORMATION:

BUILDER/APPLICANT: Florida Gas Co.
DESIGNER: Helman, Hurley, Charvat, Arch.
SOLAR SUB: Chrysler Corp.
LOCATION: Winter Springs, FL — **LATITUDE:** 28°40'N
HOUSING TYPE: SFD, 1 unit — **AREA:** 1,548 sq. ft.
CLIMATIC DATA:
HEATING DD: 766 — COOLING HRS: 3,456
DESIGN TEMP: WINTER: 60° F — SUMMER: 94° F
HORIZ. INSOL. JAN. DAY: 1,104 BTU/ft² — % SUN/YR: 68%



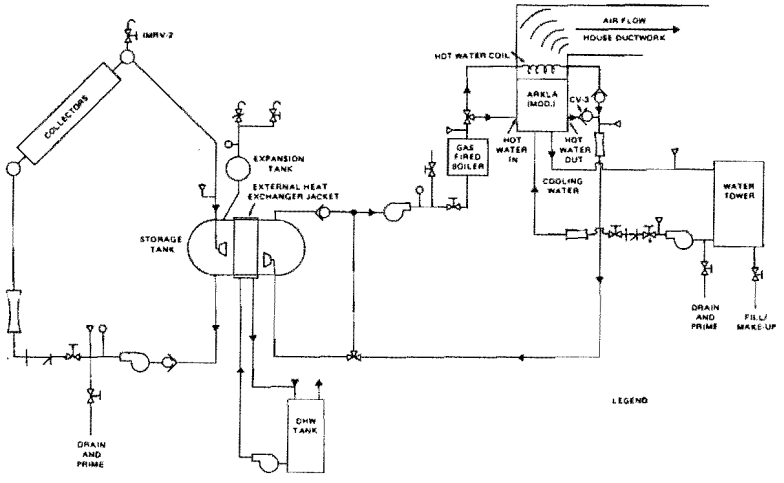
BUILDING DESCRIPTION/ENERGY CONCERNS

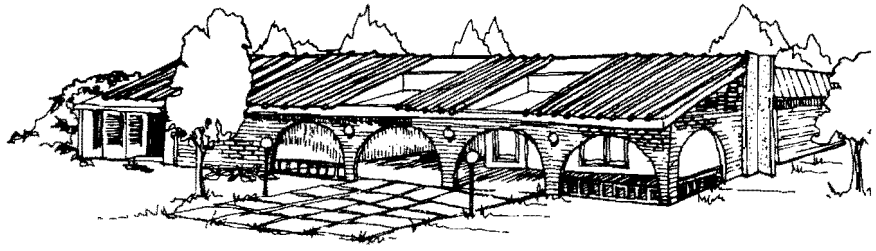
This single family detached home has 1,548 sq. ft. of floor area and 3 bedrooms. The garage is located on the northeast corner of the house as a protective thermal mass, with the length of the house facing south for maximum winter sun exposure. Other energy conservation features include 5½" of wall insulation, and 9" of mineral wool ceiling insulation. Overhangs on the southern face, as well as trees on the north, east and west sides, shade the building from the summer sun.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating, Cooling, & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 95.4%

COLLECTOR: 714 sq. ft. of flat plate liquid collectors are standoff mounted to the roof, facing 22° west of south at an 18° tilt. Manufactured by Chamberlain, these collectors circulate hot water and use the drain down method to prevent freezing of the circuit. Water is used to transfer the sun's heat to water storage.
STORAGE: 1,345 gallons of water are located underground below the cooling tower, in a steel enclosure with 4 to 6" of insulation. From here, water is pumped through a gas-fired boiler, which can heat assist, to a hot water coil in the supply ducts.
DISTRIBUTION: Forced hot air.
AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by a gas-fired boiler, which can also act as an assist to maintain the high temperatures needed for absorption cooling.
DOMESTIC HOT WATER: Water is preheated in a double heat exchanger located in solar storage, and transported to a 50 gallon hot water heater. This heater can act on its own as a conventional hot water heat source.
COOLING: High temperature solar storage provides heat to the lithium-bromide cycle in the absorption chiller.
MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat, cooling.

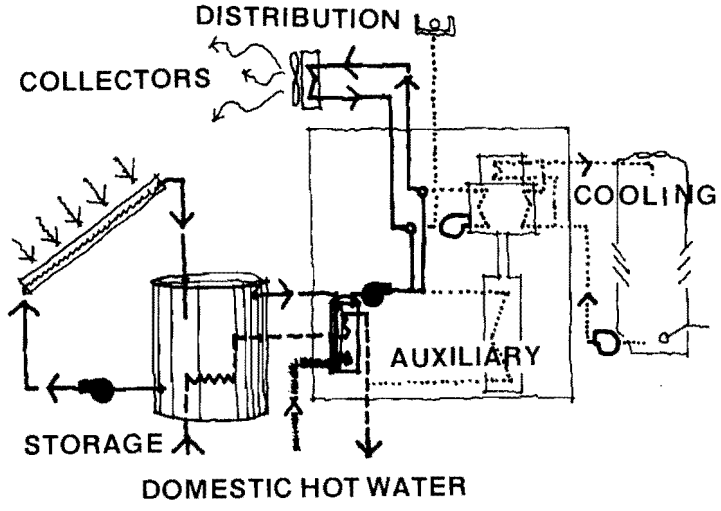




PROJECT INFORMATION:
BUILDER/APPLICANT: Gordon Deering
DESIGNER: Ernst Kielsing, Arch.
SOLAR SUB: Owens-Illinois
LOCATION: Lubbock, TX — **LATITUDE:** 33°39'N
HOUSE TYPE: SFD, 1 unit — **AREA:** 2,500 sq. ft.
CLIMATIC DATA:
HEATING DD: 3,578 — COOLING HRS: 1,647
DESIGN TEMP: WINTER: 4° F — SUMMER: 99° F
HORIZ. INSOL. JAN. DAY: 980 BTU/ft² — % SUN/YR: 76%

BUILDING DESCRIPTION/ENERGY CONCERNS

This single family detached house has 2,500 sq. ft. of space and 3 bedrooms. In order to respond to the heavy winds in the area, the building has a low profile, single story with Mansard roofs. The garage is located on the north side of the building, acting as an insulating thermal mass. Landscaping is planned to break the northwest winds, and there is berming on the west face. The use of deciduous vegetation on the east and west shades the building from the summer sun, but allows winter heat gain, while overhangs shield from the high southern sun. Other insulative features include massive walls, minimum window openings and double glazing.



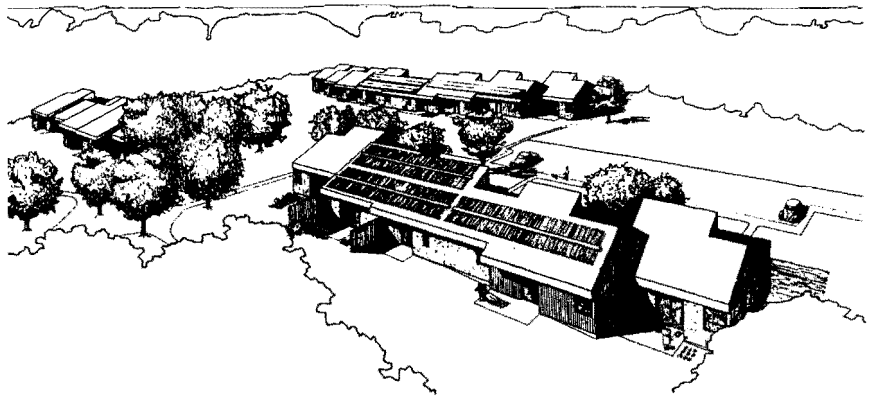
SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating, Cooling & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 95%

COLLECTOR: 328.8 sq. ft. of evacuated tube collectors are integrated into the southern roof structure at a 35° tilt. Manufactured by Owens-Illinois, these collectors pulse the fluid flow to maintain temperature above freezing. Water alone is used to transfer the sun's heat to water storage.
STORAGE: 600 gallons of water are located underground below the utility room in an insulated tank; from here heated water is pumped through a boiler, which can heat assist, to a fan coil unit in the supply air ducts.
DISTRIBUTION: Forced hot air with ceiling distribution.
AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by a gas-fired boiler of 50,000 BTUH capacity, which can also provide hotter water for the absorption cooling cycle.
DOMESTIC HOT WATER: City water supply is first preheated in a closed coil in solar storage, and then given a heat boost in the gas-fired boiler.
COOLING: High temperature heat from the collector is transported to a VAZAKI cooler which uses the heat in the lithium-bromide cycle of an absorption chiller.
MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat, cooling.

TEXAS
3578 DD
SFD NEW
ACTIVE H, C, & DHW
51

PROJECT INFORMATION:
BUILDER/APPLICANT: Durham Housing Authority
DESIGNER: John T. Latimer & Associates, Inc.
SOLAR SUB:
LOCATION: Durham, N.C. **LATITUDE:** 36°N
HOUSING TYPE: SFA, 18 Units **AREA:** 519-730 sq. ft.
CLIMATIC DATA:
HEATING DD: 3,393 COOLING HRS: 750
DESIGN TEMP: WINTER: 15° F SUMMER: 92° F
HORIZ. INSOL. JAN. DAY: 850 BTU/FT² % SUN/YR: 61%

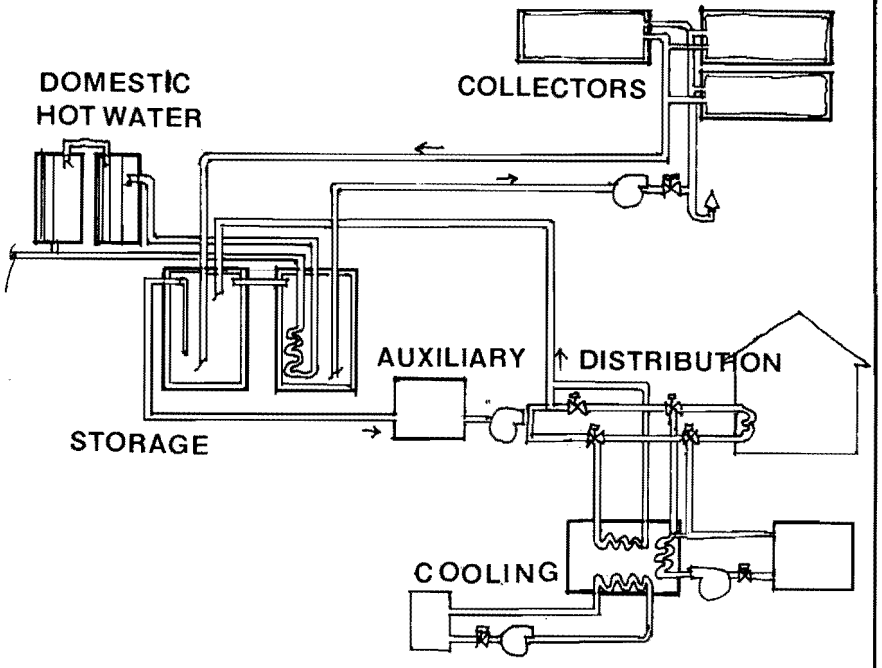


BUILDING DESCRIPTION/ENERGY CONCERNS

This project has 18 units of three types with 4 to 6 units per townhouse grouping. Each unit encompasses 519 to 730 sq. ft. of space. Energy conservation features include minimum window openings on the north face, no openings on the east and west faces, and overhangs on the south face. Clerestories are placed facing north to minimize summer heat gain, while the roof itself is heavily insulated against heat transfer.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating, Cooling & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 79%



COLLECTOR: 166 sq. ft. of evacuated tube liquid collectors are standoff mounted to the south facing roofs at a 30° tilt. Manufactured by Owens-Illinois, these collectors use water to transfer the sun's heat to water storage. When necessary, antifreeze is added to prevent freezing.

STORAGE: 6,000 gallons of water are located centrally in 2 tanks per townhouse grouping. The tanks are phenol lined steel with 3" of styrofoam insulation. From here, water is pumped to local fan coil units, and heated air is blown into the space.

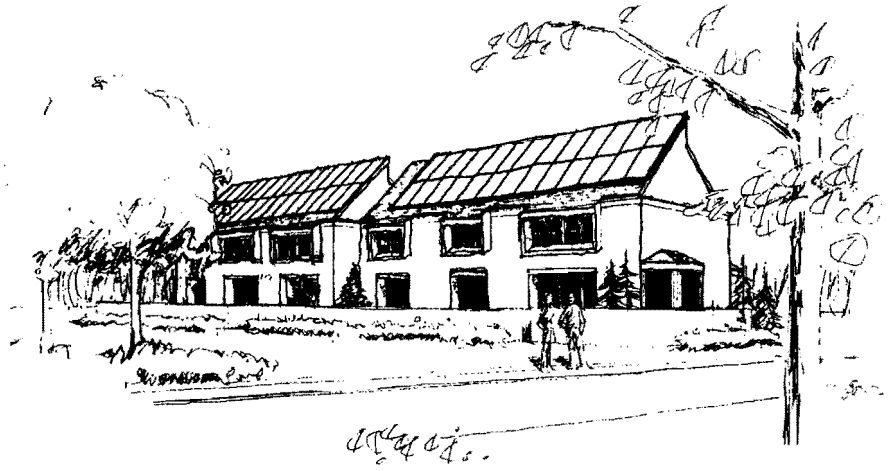
DISTRIBUTION: A hydronic system to each fan coil unit is combined with forced air distribution.

AUXILIARY ENERGY SYSTEM: A gas fired boiler of 400,000 BTUH capacity is used as backup for the heating & absorption chiller systems.

DOMESTIC HOT WATER: City water is preheated in a copper heat exchange coil located in solar storage. From here water is circulated to one of 2 conventional gas-fired 100-gallon domestic hot water heaters located in the utility room of each townhouse group.

COOLING: Cooling is provided by Arkla absorption chillers combined with a cooling tower. This operates with high temperature heat from the evacuated tube collectors.

MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat, cooling.



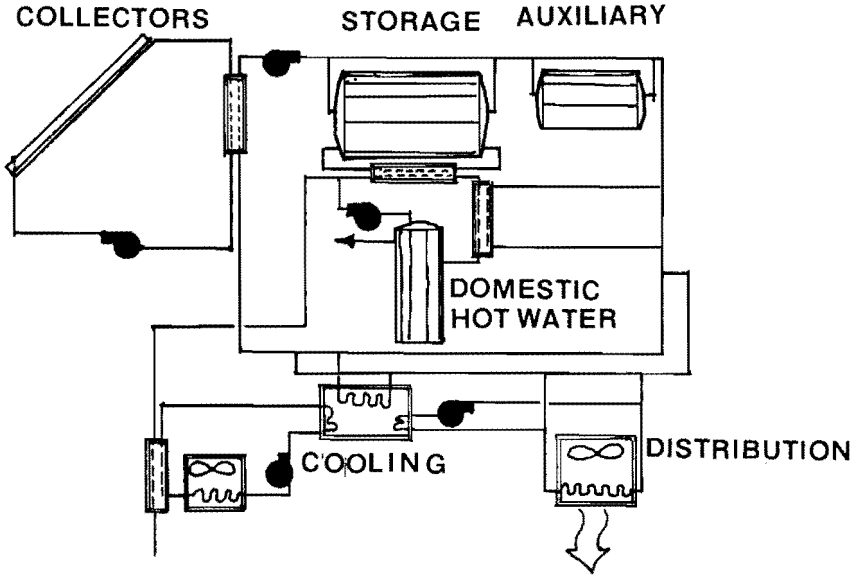
PROJECT INFORMATION:
BUILDER/APPLICANT: City of Flint, Dept. of Community Development
DESIGNER: Tomblinson, Harburn & Yurk, Architects
SOLAR SUB: General Electric Space Division
LOCATION: Flint, MI — **LATITUDE:** 43°N
HOUSING TYPE: SFA, 6 Units — **AREA:** 1,224 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 7,377 — COOLING HRS: 500
DESIGN TEMP: WINTER: −10° F — SUMMER: 95° F
HORIZ. INSOL. JAN. DAY: 460 BTU/ft² — % SUN/YR: 53%

BUILDING DESCRIPTION/ENERGY CONCERNS

This project includes six new solar heated and cooled townhouses, each with 2 or 3 bedrooms. Energy conservation features include recessed and shaded windows on the south, and a small porch on the north which forms an airlock entry. The double glazed windows have thermal break sashes. The trees act as shading devices and wind buffers. Insulation has been built up to prevent both heat gain and heat loss.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating, Cooling, & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 72%



COLLECTOR: Located on the south facing roof, the collectors are concentrating evacuated tubes, with reflectors to intensify heat. A mixture of 40% ethylene glycol and 60% water is used as the heat transfer medium. The collectors are mounted at an angle of 48° and cover an area of 1,617 sq. ft. They are manufactured by General Electric.

STORAGE: An indoor 5,000 gallon water tank provides storage for collected heat. A heat exchanger in the tank transfers the solar heat to storage water.

DISTRIBUTION: Air is forced across a hot or cold coil in the air duct for distribution.

DOMESTIC HOT WATER: Incoming water passes through one of several heat exchangers (depending on the mode in which the system is operating), where it is preheated before entering the domestic hot water heater.

COOLING: Arkla absorption chiller units operate using high temperature heat from the concentrating collectors.

AUXILIARY ENERGY SYSTEM: An oil-fired boiler with a capacity of 150,000 BTUH provides auxiliary heated water for heating, DHW and cooling.

MODES OF OPERATION: Collector to storage, storage to house, auxiliary to house, cooling with storage assist, DHW preheat.

53

LOUISIANA

1670 DD

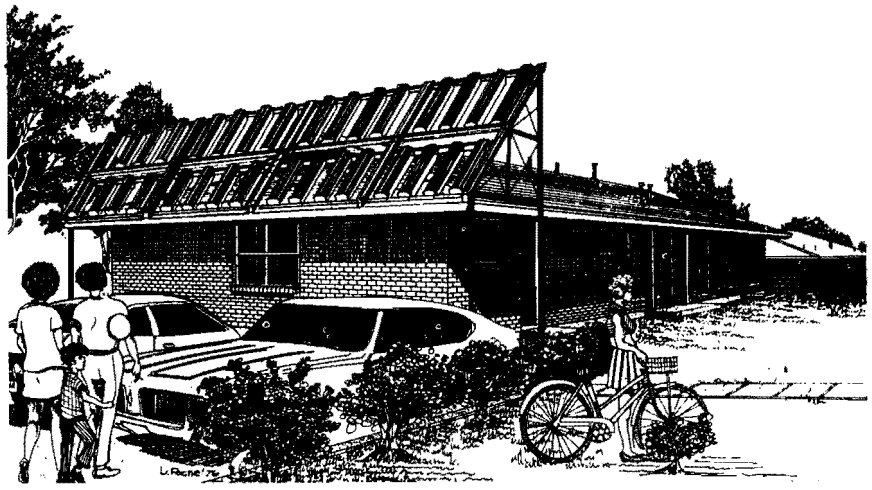
2 SFA RETRO

ACTIVE H, C, & DHW

54

PROJECT INFORMATION:

BUILDER/APPLICANT: Baton Rouge Parish Housing Authority
DESIGNER: Morgan Watson
SOLAR SUB: Minority Engineers of Louisiana
LOCATION: Baton Rouge, LA
LATITUDE: 30°30'N
HOUSING TYPE: SFA, 2 Units
AREA: 1,033 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 1,670
COOLING HRS: 2,140
DESIGN TEMP: WINTER: 25° F
SUMMER: 94° F
HORIZ. INSOL. JAN. DAY: 858 BTU/ft²
% SUN/YR: 60%



BUILDING DESCRIPTION/ENERGY CONCERNS

This project includes one single-story retrofit duplex unit. The buildings are compact and rectangular with overhangs on all sides to shade from the summer sun.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating, Cooling, & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 77%

COLLECTORS: 388 sq. ft. of Northrup concentrating trough collectors (standoff mounted for tracking), are located on the end of the duplex unit. Water, tempered with antifreeze in winter, is used as the heat transport fluid in a closed loop through storage.

STORAGE: 2,000 gallons of water storage for each duplex is held in steel cylindrical tanks and insulated with R30 glass fiber insulation.

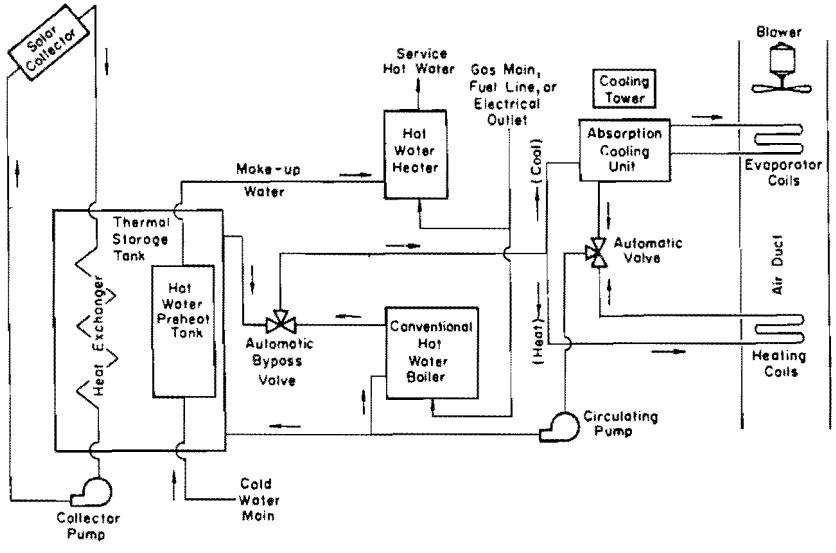
DISTRIBUTION: Water is pumped through heating coils located in the air duct for forced hot air distribution.

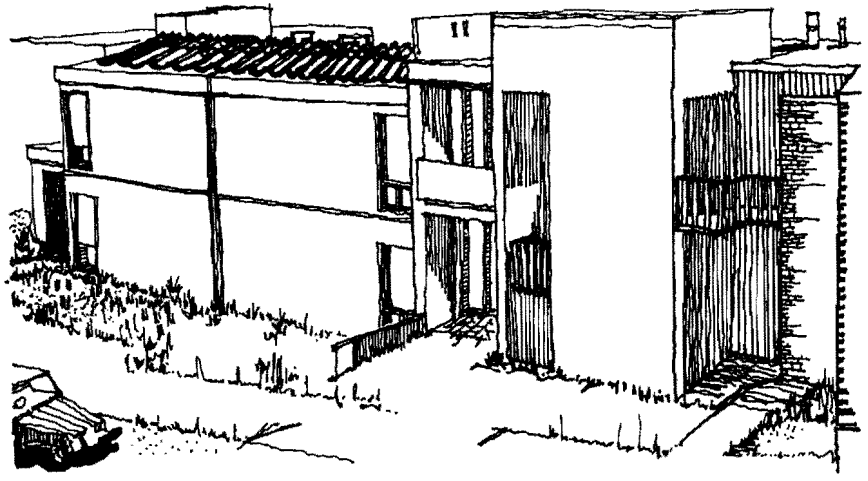
AUXILIARY ENERGY SYSTEM: A gas boiler with 400,000 BTUH capacity acts as backup hot water supply for the heating coils in the air ducts.

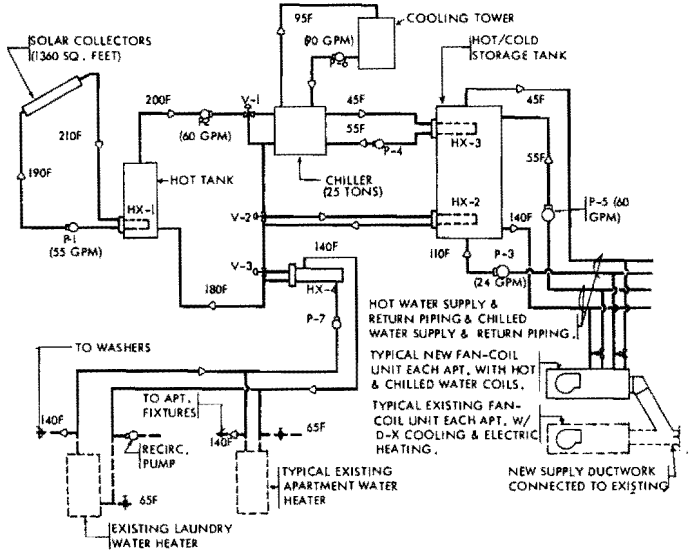
DOMESTIC HOT WATER: Cold water is supplied to a 40 gallon hot water preheat tank located in storage and preheated before going to a conventional hot water tank.

COOLING: An Arkla-absorption chiller unit combined with a cooling tower operates with high temperature heat from the concentrating collectors. The high temperature heat is supplied from the collector to the evaporator coils in the absorption cycle.

MODES OF OPERATION: Collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat, cooling.







PROJECT INFORMATION:
BUILDER/APPLICANT: University of Texas, Austin
DESIGNER: Han-Mer Consulting Engineers, Inc.
SOLAR SUB:
LOCATION: Austin, TX
LATITUDE: 30°22'N
HOUSING TYPE: MF Low, 12 Units
AREA: 600 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 1,711
COOLING HRS: 2,200
DESIGN TEMP: WINTER: 29° F
SUMMER: 98° F
HORIZ. INSOL. JAN. DAY: 940 BTU/ft²
% SUN/YR: 65%

BUILDING DESCRIPTION/ENERGY CONCERNS

These 12 units of multi-family garden apartments encompass 600 sq. ft. of space each and have one bedroom per unit. The apartments have been retrofitted with solar heating, cooling and DHW. Energy conservation features include selecting buildings that face south and have improved insulation throughout. There are no windows on the east or west faces to prevent unnecessary summer heat gain.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating, Cooling, & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 76%

COLLECTOR: 1,360 sq. ft. of linear fresnel concentrating collectors are rack mounted to the southern roof at a 20° tilt. Manufactured by Northrup, these liquid collectors use antifreeze (glycol and water) to prevent freezing in the circuit. The antifreeze solution transfers the sun's heat to a hot water tank heat exchanger, and then to water storage.

STORAGE: 6,000 gallons of water are contained in a glass lined steel tank located in the apartment's mechanical room. From here, water is pumped through piping to fan heating/cooling coil units and air is blown over the coil for distribution.

DISTRIBUTION: Forced hot air.

AUXILIARY ENERGY SYSTEM: Auxiliary energy is supplied by an electric heat pump with local electric resistance heaters as backup.

DOMESTIC HOT WATER: A closed preheat coil circulating from solar storage to the conventional electric hot water tank, preheats the domestic hot water.

COOLING: High temperature liquid from the collector is taken to a 25 ton lithium-bromide/H20 absorption water chiller. Any excess cold water production is taken to the water storage tank for later use.

MODES OF OPERATION: Collector to storage, storage to house, auxiliary to house, DHW preheat, cooling, cooling to storage.

TEXAS

1711 DD

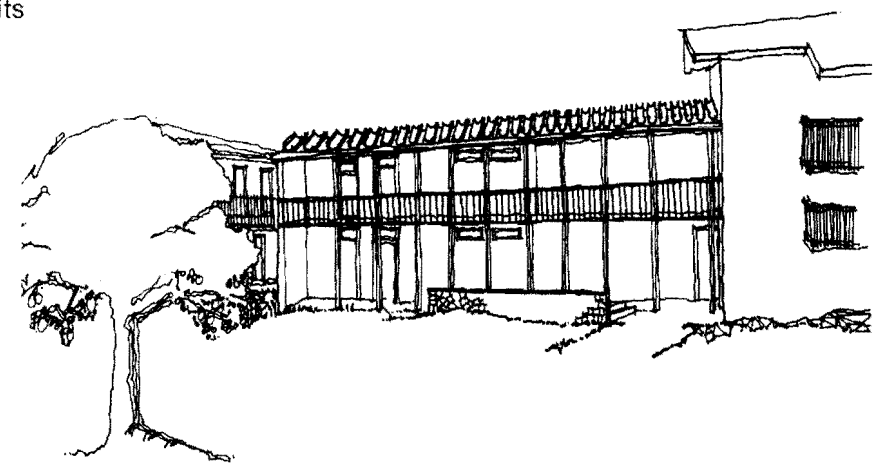
MF LOW RETRO

ACTIVE H, C, & DHW

56

PROJECT INFORMATION

BUILDER/APPLICANT: College Houses
DESIGNER: Ham-Mer Consulting Engineers, Inc.
SOLAR SUB: George Smith, Inc.
LOCATION: Austin, TX
LATITUDE: 30°N
HOUSING TYPE: MF Low, 80 Units
AREA: 27,500 sq. ft./80 units
CLIMATIC DATA:
HEATING DD: 1,711
COOLING HRS: 2,200
DESIGN TEMP: WINTER: 29° F
SUMMER: 98° F
HORIZ. INSOL. JAN. DAY: 940 BTU/ft²
% SUN/YR: 64%



BUILDING DESCRIPTION/ENERGY CONCERNS

An existing two story college dormitory, this building includes no recent modifications except the addition of the solar system.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Heating, Cooling, & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 54%

COLLECTOR: 3,350 sq. ft. of focusing, fresnel lens collectors have been rack mounted, for tracking, at a 30° tilt on the flat roof of these dormitories. Manufactured by Northrup, Inc., these collectors use inside prisms to focus solar radiation onto a copper absorber.

STORAGE: Heat collected by the 50% ethylene-glycol antifreeze solution is transferred to storage water through a shell and tube heat exchanger located in storage. 6,000 gallons of water storage is located in the basement of the dormitory in a cylindrical steel tank with 2" fiberglass insulation.

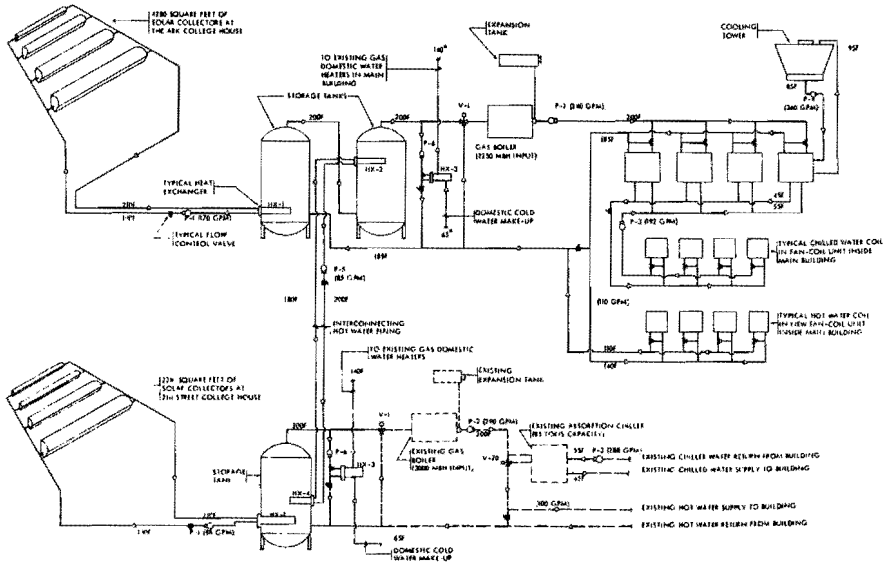
DISTRIBUTION: Individual fancoil units blow air across hydronic coils to provide hot air distribution.

AUXILIARY ENERGY SYSTEM: An existing gas hot water boiler provides 1,800,000 BTUH backup energy to the fancoil units.

DOMESTIC HOT WATER: A second heat exchanger allows city water supply to pass through hot water storage, preheating potable water on its way to the existing DHW tanks.

COOLING: An Arkla absorption chiller unit combined with a cooling tower operates with high temperature heat from the high performance focusing collectors.

MODES OF OPERATION: Collector to storage (via heat exchanger), storage to house, storage to auxiliary to house, cooling, DHW, preheat.



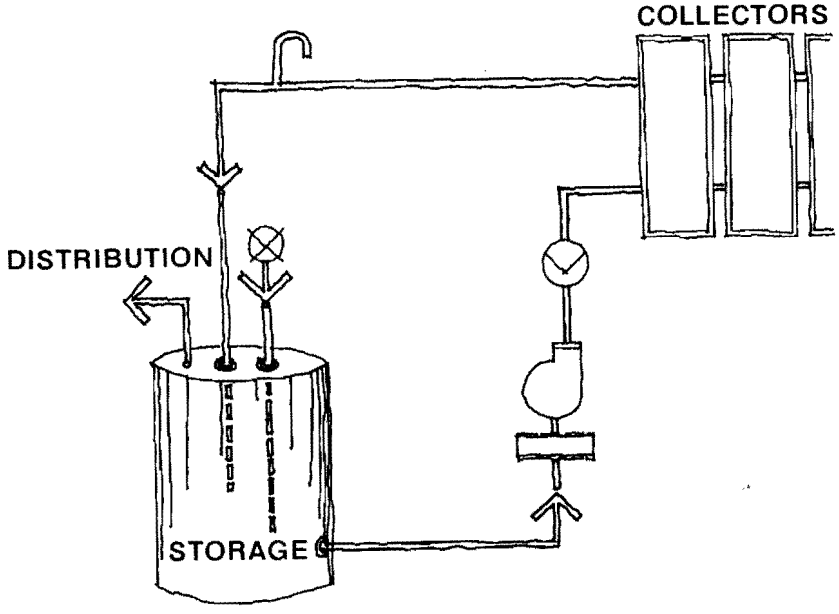
BUILDER/APPLICANT: Dalton Housing Authority
DESIGNER: Associated Architects, Inc.
SOLAR SUB: Solar Development Inc.
LOCATION: Dalton, GA
HOUSING TYPE: SFA, 12 Units
CLIMATIC DATA:
HEATING DD: 3,254
DESIGN TEMP: WINTER: 43° F
HORIZ. INSOL. JAN. DAY: 730 BTU/ft²

LATITUDE: 34°5'N
AREA: 884 sq. ft./unit

COOLING HRS:
SUMMER: 80° F
% SUN/YR: 70%

BUILDING DESCRIPTION/ENERGY CONCERNS

These 12 units of new 2 bedroom townhouses include several construction features for energy conservation. The houses, a compact 884 sq. ft. each, face north and south, while east and west facades are closed end walls or party walls. Wall insulation has been increased to 6" in thickness between 2x6 studs, 24" on center. Walls are sheathed in polystyrene and the floor slab perimeter is protected against heat loss by 2" of rigid insulation.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 88%

COLLECTOR: 720 sq. ft. total (60 sq. ft. per unit) of flat plate liquid collectors have been direct mounted, south facing, at a 45° tilt on the roofs of the 12 attached units. Manufactured by Solar Development Inc., the system pumps city water directly through the collectors to preheat the domestic hot water supply.

STORAGE: 52 gallons of water, contained in the insulated DHW heater in each unit, acts as both solar storage and conventional DHW storage. City water that has been heated in the collectors provides almost 100% of the DHW needs directly and is stored in the 52 gallon tank.

AUXILIARY ENERGY SYSTEM: An electric resistance heating element has been placed in the top of this DHW tank, can provide an auxiliary DHW capacity of 18,770 BTUH.

PROJECT INFORMATION:

Cases 58-69 involve the same type of active domestic hot water system; therefore, they will be described in one group.

BUILDERS/APPLICANTS	LOCATION
• Miles & Teal Builders	Myrtle Beach, SC
• Contemporary Homes, Inc.	Cohutta, GA
• Lamar Wilbanks	Commerce, GA
• Owens & Park, Inc.	Dalton, GA
• Brown, Wilburn, Inc.	Ringgold, GA
• Lynn Redman	Knoxville, TN
• Richard Ramsdes	Knoxville, TN
• D. K. Dossett	Knoxville, TN
• Architectural Developers, Inc.	Knoxville, TN
• GLS Construction Company	Winston-Salem, NC
• Frank Robuck, Jr.	Cary, NC
• Thomson & Associates	Asheville, NC

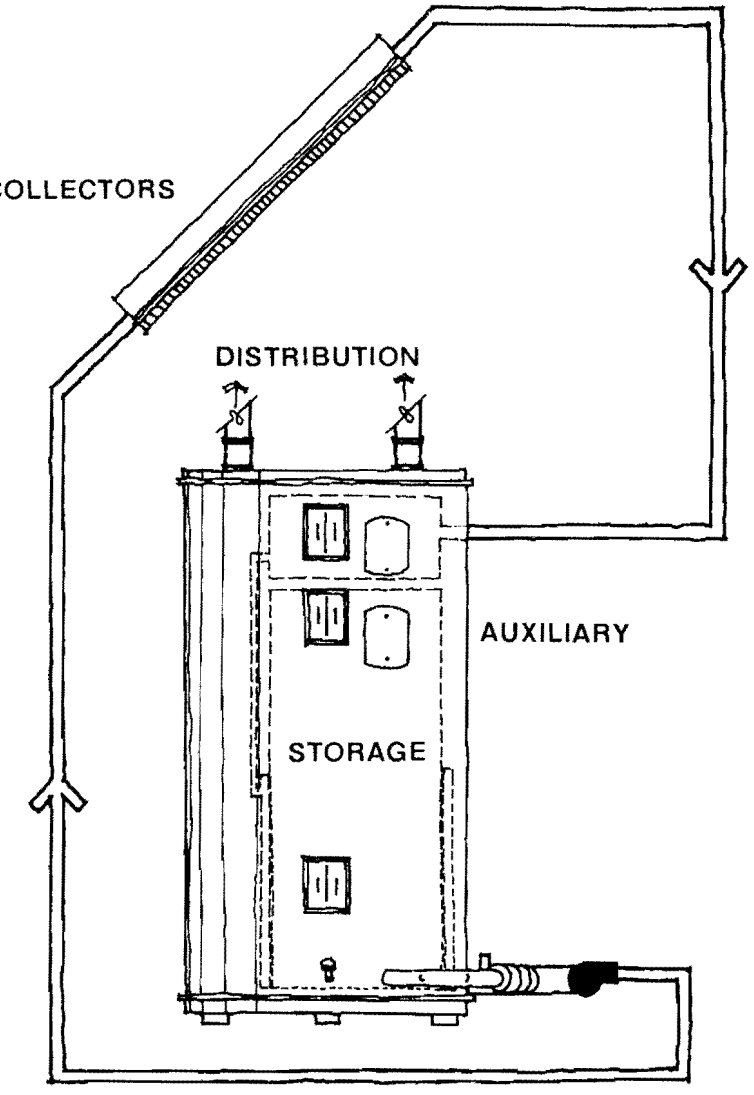
LATITUDE (RANGE): 33°-36°N

HOUSING TYPE: SFD

AREA (RANGE): 1,300-3,000 sq. ft.

CLIMATIC DATA (RANGES):

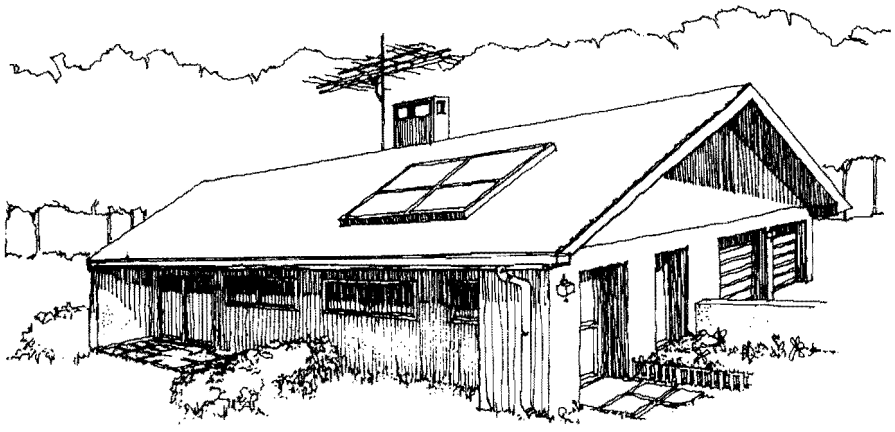
HEATING DD: 2,484-4,042 COOLING HRS:
DESIGN TEMP: WINTER: 38-47° F SUMMER: 72-81° F
PEAK DAY JAN. INSOL: 610-830 BTU/ft² % SUN/YR: 58-64%



58 to

BUILDING DESCRIPTION/ENERGY CONCERNS

These projects involve single family detached homes with 2 to 3 bedrooms. The number of units in each application ranges from 1 to 5. The smallest unit is 1,300 sq. ft. and the largest is 3,000 sq. ft.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 43-54%

COLLECTOR: Each of the single family homes has 48 sq. ft. of flat plate collector, manufactured by Energy Converters. They are rack mounted on the roofs of the houses at a tilt conforming to the general rule for domestic hot water design, i.e., at a latitude +5° tilt. Water, with corrosion inhibitors, is used as the transfer media, while freezing is prevented by the drain-down method. A pump forces the water through the collector then to a holding tank which is located directly above the storage tank. Heated water is then circulated from the holding tank through a heat exchanger (annular jacket type) which wraps around the storage tank.

STORAGE: An 80 gallon steel hot water tank is located as close to the collector as possible. Heat is transferred from the solar heat exchanger surrounding the tank.

DISTRIBUTION: Conventional hot water system.

AUXILIARY ENERGY SYSTEM: The upper 25 gallons of water is kept heated by a 6,000 watt electric element, providing up to 20,500 BTUH.

CALIFORNIA

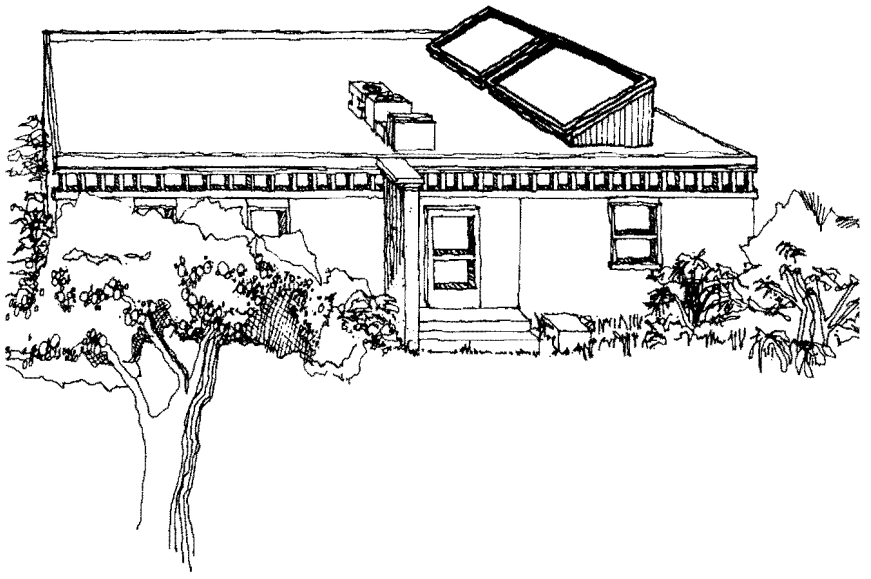
1300, 1525 DD

2 SFD RETRO

ACTIVE DHW

PROJECT INFORMATION:

BUILDER/APPLICANT: Cal. Dept. Energy Conservation & Development
DESIGNER: Office of the State Architect
SOLAR SUB:
LOCATION: Southern California
LATITUDE: 34°N
HOUSING TYPE: SFD, 2 Units
AREA: 1,200 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 1,300, 1,525
COOLING HRS:
DESIGN TEMP: WINTER: 31°-43° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 977 BTU/ft²
% SUN/YR: 65%, 80%



BUILDING DESCRIPTION/ENERGY CONCERNS

These 2 bedroom, single family detached homes are ranger's houses in California state parks. Energy conserving features include a garage on one unit, located to the northwest to reduce heat loss from the winter winds, and overhangs on the south side of each unit to shade from the summer sun.

SOLAR ENERGY SYSTEM: ACTIVE

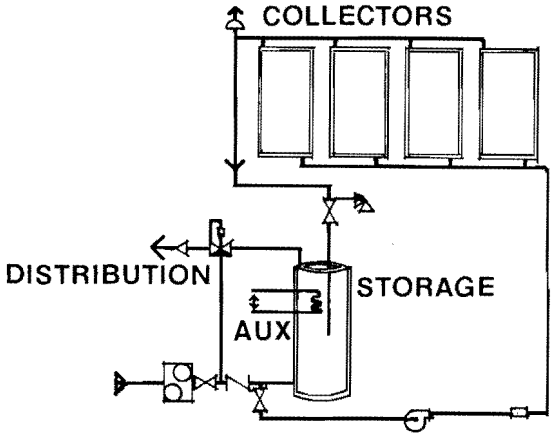
SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 79%, 89%

COLLECTOR: Both units use 49-66 sq. ft. of PPG Industries flat-plate collectors on their roofs, one directly mounted on the south facing, 26° tilted roof and the other rack mounted at a 42° tilt. Water is pumped through the collectors to gather the sun's energy.

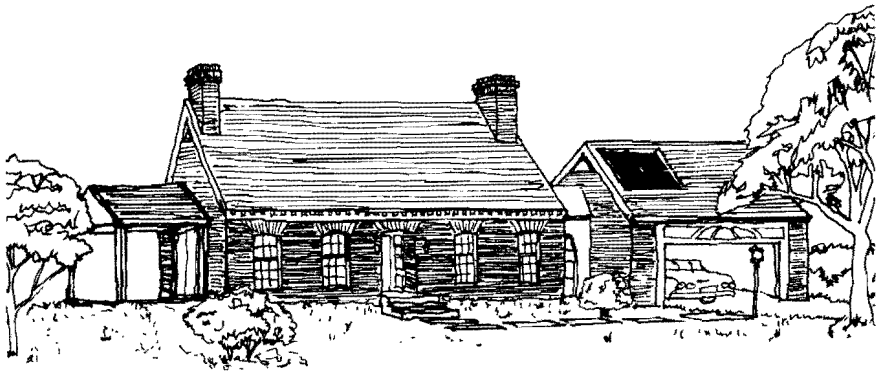
STORAGE: A 120 gallon hot water storage tank is located in the utility room of each unit. Water is pumped directly into the tank from the collectors.

DISTRIBUTION: Water is taken from the top of the storage tank to locations in the unit.

AUXILIARY ENERGY SYSTEM: An electric resistance coil in the hot water tank provides auxiliary heat.



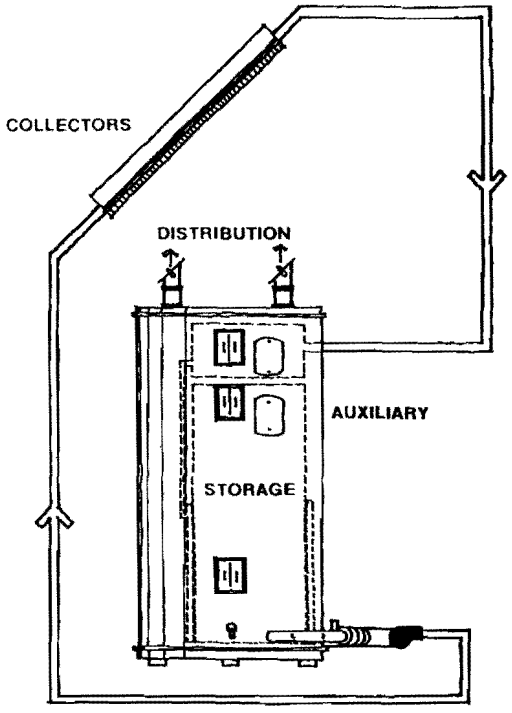
70



PROJECT INFORMATION:
BUILDER/APPLICANT: R. H. Sinclair Construction Co., Inc.
DESIGNER: Energy Converters
SOLAR SUB: W.L. Jackson Mfg. Co.
LOCATION: Knoxville, TN
HOUSING TYPE: SFD, 1 Unit
CLIMATIC DATA:
HEATING DD: 3,254
DESIGN TEMP: WINTER: 43° F
HORIZ. INSOL. JAN. DAY: 730 BTU/ft²

LATITUDE: 35°N
AREA: 2,300 sq. ft./unit

COOLING HRS:
SUMMER: 80° F
% SUN/YR: 43%



BUILDING DESCRIPTION/ENERGY CONCERNS

This single family home is a retrofit version of the energy convertors hot water system discussed in projects 58-69.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 43%

COLLECTOR: 48 sq. ft. of flat plate collectors are located on the roof and manufactured by Energy Converters. Water, with corrosion inhibitors, is circulated from the collector to a holding tank located directly above the storage tank. From here heated water moves through an annular jacket heat exchanger surrounding the storage tank. Freezing is prevented by the drain-down method.

STORAGE: An 80-gallon water tank is used to store collected heat.

DISTRIBUTION: Conventional hot water system.

AUXILIARY ENERGY SYSTEM: An electric element in the hot water storage tank keeps the upper 25 gallons heated. Its capacity is 20,500 BTUH.

TENNESSEE
3254 DD
1 SFD RETRO
ACTIVE DHW
71

COLORADO

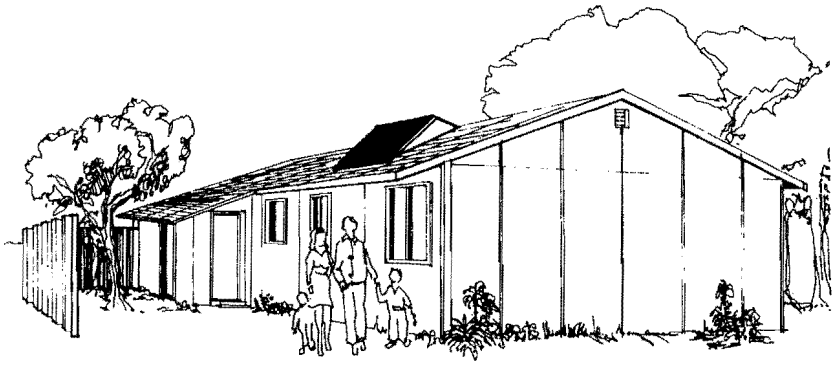
5402 DD

18 SFD RETRO

ACTIVE DHW

72

PROJECT INFORMATION:
BUILDER/APPLICANT: Colorado Rural Housing Dev. Corp.
DESIGNER: Joseph T. Gude
SOLAR SUB: American Heliothermal Corp.
LOCATION: Granada, CO
LATITUDE: 38°
HOUSING TYPE: SFD, 18 Units
AREA: 982-1,122 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 5,402
COOLING HRS:
DESIGN TEMP: WINTER: −5° F
SUMMER: 99° F
HORIZ. INSOL. JAN. DAY: 980 BTU/ft²
% SUN/YR: 70%

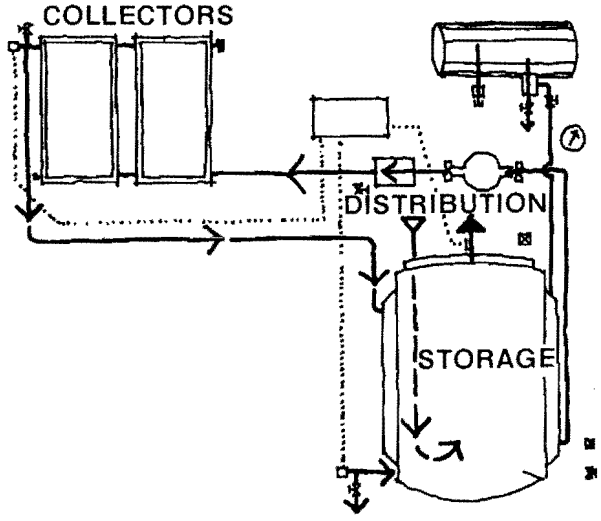


BUILDING DESCRIPTION/ENERGY CONCERNS

Eighteen single family units and a common laundry facility are retrofitted with solar heated domestic hot water systems. Each unit has 982 to 1,122 sq. ft. of living area and the laundry has 1,000 sq. ft. Energy conservation features include minimal windows on east and west faces to insulate against summer heat gain and winter heat loss. Buildings are oriented so that the long axis faces north+south, providing a maximum southern exposure.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 100%

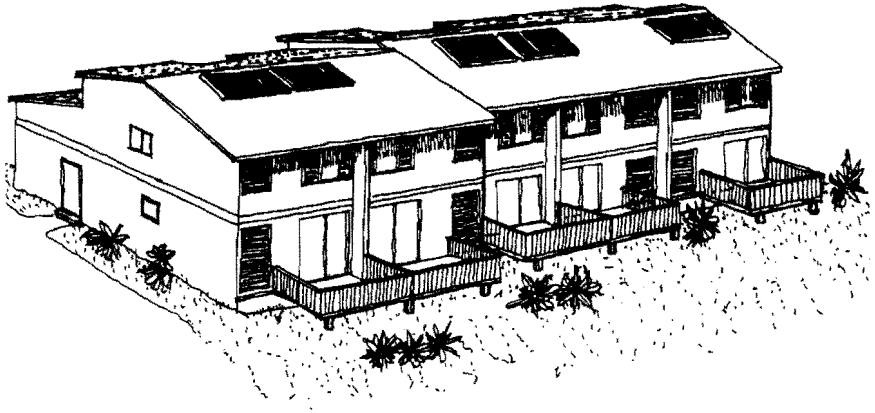


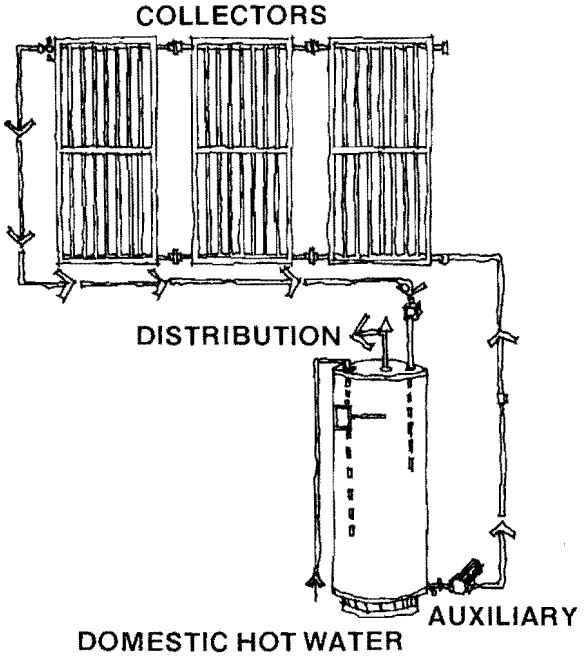
COLLECTOR: 698 total square feet of flat plate collectors are located on the south facing roofs of the buildings at a 30° tilt. They are American Heliothermal Miromit collectors, using an antifreeze mixture as the transfer medium. Within the housing units heat is exchanged through an annular jacket surrounding a storage tank, while in the laundry building a fin coil is immersed in the storage tank to transfer heat from the antifreeze fluid to water.

STORAGE: Each dwelling unit has a 66-gallon water storage tank, and the laundry has a 1,200 gallon tank.

DISTRIBUTION: City water pressure distributes the preheated water to its destination.

AUXILIARY ENERGY SYSTEM: Separate gas-fired hot water heaters act as the assist to the solar system, with 42,000 BTU capacity in the single family homes and a 360,000 BTU capacity in the laundry.





PROJECT INFORMATION:
BUILDER/APPLICANT: Finance Realty Co., Ltd.
DESIGNER: Wong & Wong Associates
SOLAR SUB: Sunsource, Inc.
LOCATION: Ewa Beach, HI
LATITUDE: 21°N
HOUSING TYPE: SFA, 5 Units
AREA: 1,297-1,505 sq. ft/ unit
CLIMATIC DATA:
HEATING DD: 0
COOLING HRS:
DESIGN TEMP: WINTER: 75° F
SUMMER: 85° F
HORIZ. INSOL. JAN. DAY: 1,320 BTU/ft²
% SUN/YR: 75-80%

BUILDING DESCRIPTION/ENERGY CONCERNS

Five units of townhouses are located in Honolulu, each with 2 or 3 bedrooms in 1,297 and 1,505 sq. ft. Energy conserving features include closing east and west walls into party walls, thus windowless and insulated against the sun. Clerestories provide a high window for ventilation. For shading, four foot overhangs are used over all south facing windows, as well as trees placed near the southeast and southwest corners.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 93%

COLLECTOR: 3 flat plate collectors are mounted on each unit for a total of 57 sq. ft. per unit. The Miromit collectors are standoff mounted on the south facing roof and placed at a 30° tilt. Water is pumped directly through the collectors to a DHW storage in each house.

STORAGE: 120 gallons of hot water storage per unit is located in steel heater tanks wrapped in 3" of rigid urethane insulation. 130° water can be provided directly from the tank and auxiliary heated if necessary.

AUXILIARY ENERGY SYSTEM: A 2KW electric resistance coil at the top of the DHW tank adds heat to the preheated water supply, or handles the total 150,000 BTUH hot water load.

HAWAII
0 DD
5 SFA NEW
ACTIVE DHW
73

ALABAMA

3254 DD

5 SFA NEW

ACTIVE DHW

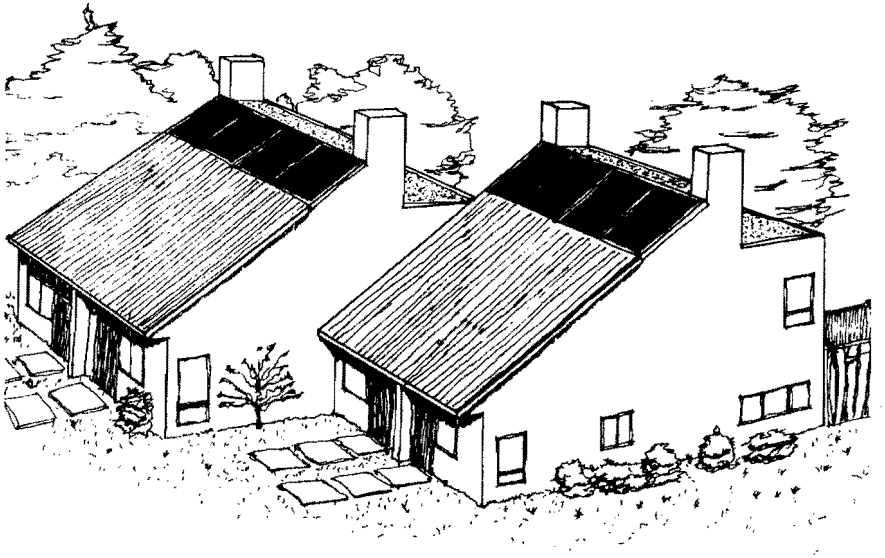
74

PROJECT INFORMATION:

BUILDER/APPLICANT: Housing Development Co.
DESIGNER: Energy Converters
SOLAR SUB: W.L. Jackson Mfg. Co.
LOCATION: Madison, AL
HOUSING TYPE: SFA, 5 Units
CLIMATIC DATA:
HEATING DD: 3,254
DESIGN TEMP: WINTER: 43° F
HORIZ. INSOL. JAN. DAY: 730 BTU/ft²

LATITUDE:
AREA: 1,500 sq. ft./unit

COOLING HRS:
SUMMER: 80° F
% SUN/YR: 58%



BUILDING DESCRIPTION/ENERGY CONCERNS

This project consists of 5 new single family attached homes employing the Energy Converters solar hot water system described in projects 58-69.

SOLAR ENERGY SYSTEM: ACTIVE

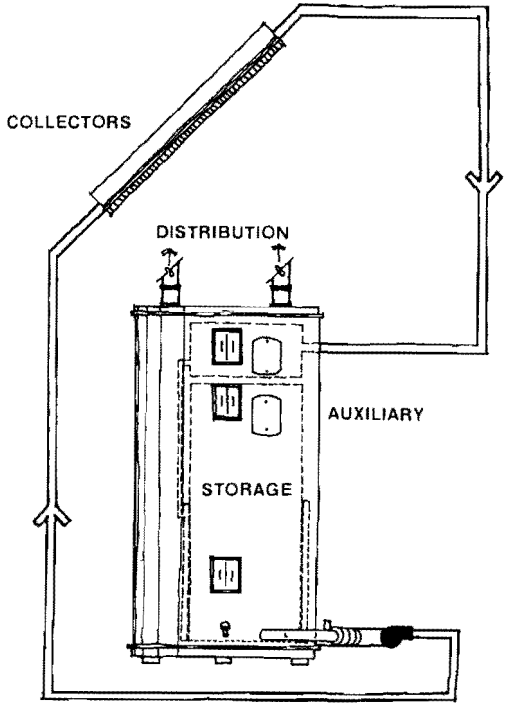
SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 43%

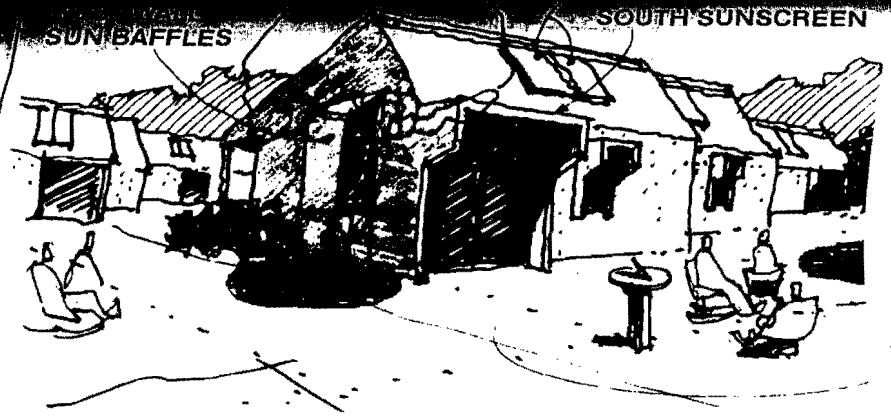
COLLECTOR: The Energy Converters system includes 45 sq. ft. of collector, integrally mounted on the roof of the building. Water, with corrosion inhibitors, is the transfer medium, carrying collected heat to a holding tank above the storage tank. Solar heated water is then circulated through an annular jacket heat exchanger which surrounds the storage tank.

STORAGE: An 80 gallon steel water tank provides storage for solar heated water.

DISTRIBUTION: Conventional hot water system.

AUXILIARY ENERGY SYSTEM: An electric element in the storage tank keeps the upper portion heated, with a capacity of 20,500 BTUH gallons.





DESIGNER: Raymond Heinrich, Architect
SOLAR SUB: American Solar Companies, Inc.
LOCATION: S. Brunswick Twp., NJ
HOUSING TYPE: *SFA, 8 Units*
CLIMATIC DATA:
HEATING DD: 4,980
DESIGN TEMP: WINTER: 0° F
HORIZ INSOL. JAN. DAY: 553 BTU/ft²

LATITUDE: 40°19'N
AREA: *1,200 sq. ft.*

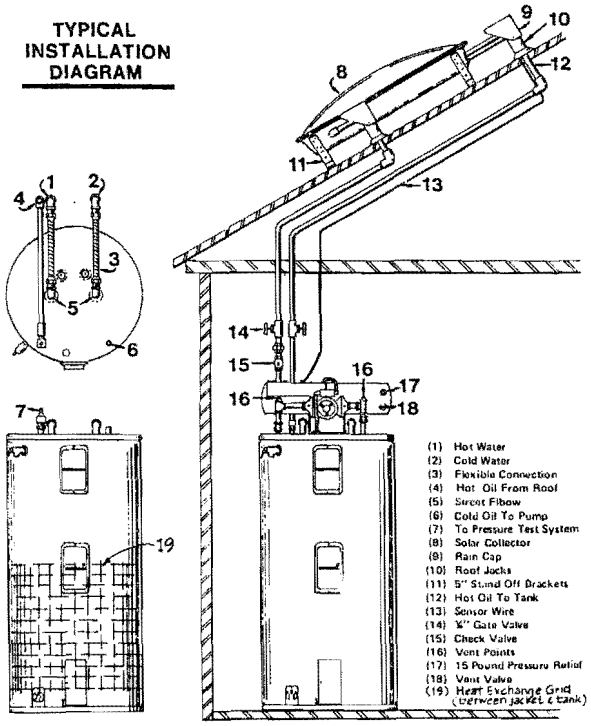
COOLING HRS:
SUMMER: 95° F
% SUN/YR: 61%

NEW JERSEY
4980 DD
8 SFA NEW
ACTIVE DHW
75

BUILDING DESCRIPTION/ENERGY CONCERNS

This project involves 8 new single family townhouses with 1,200 sq. ft. in each unit. Much study was done to decide the eventual orientation of the buildings. In these units, energy is conserved in various ways. All living areas open to south or southeast, maximizing winter heat gain. Sunscreens on the south, and vertical shading devices reduce summer heat gain, while trees are planted to provide further summer sun protection. Improved insulation is used throughout.

TYPICAL INSTALLATION DIAGRAM



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 61%

COLLECTOR: State Industries manufactured these flat plate collectors, of which 48 sq. ft./unit are roof mounted to each unit at a 60° tilt. The buildings, are oriented 10° west of south. The liquid used to transport the collected heat is silicone oil, which prolongs collector life. An annular jacket heat exchanger located around the hot water tank transfers collector heat to water storage.

STORAGE: An 82-gallon hot water tank per unit stores the heated water for domestic hot water supply.

DISTRIBUTION: Domestic hot water is distributed through the conventional system.

AUXILIARY ENERGY SYSTEM: A 4.5 KW electric heating element is located in the bottom of the hot water tank to supply auxiliary energy.

COLORADO

5505 DD

2 SFA RETROFIT

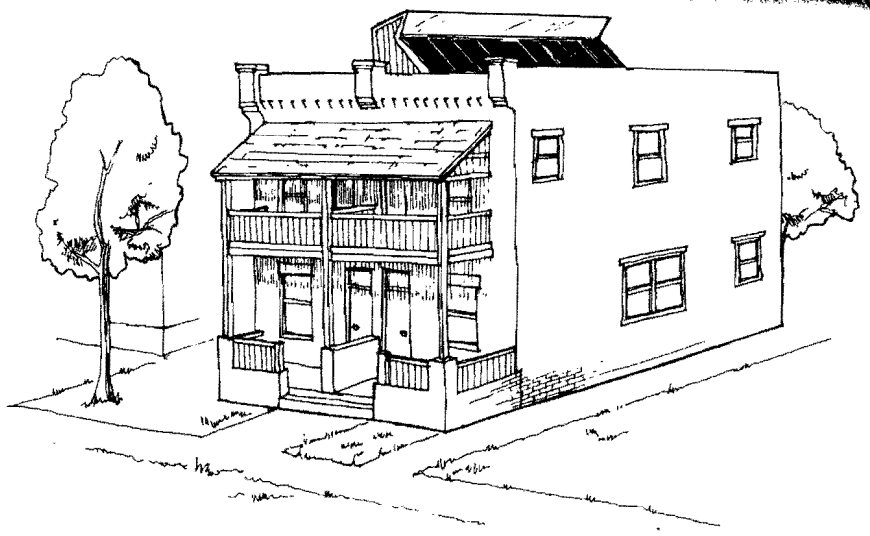
ACTIVE DHW

76

PROJECT INFORMATION:
BUILDER/APPLICANT: Brothers Redevelopment Inc.
DESIGNER: Malcolm Lilywhite, David Elfring
SOLAR SUB:
LOCATION: Denver, CO
HOUSING TYPE: SFA, 2 Units
CLIMATIC DATA:
HEATING DD: 5,505
DESIGN TEMP: WINTER: 32° F
HORIZ. INSOL. JAN. DAY: 922 BTU/ft²

LATITUDE: 40°N
AREA:

COOLING HRS: 742
SUMMER: 78° F
% SUN/YR: 70%



BUILDING DESCRIPTION/ENERGY CONCERNS

As a retrofit project of two townhouse units for solar heating of domestic hot water, no changes have been made in the building.

SOLAR ENERGY SYSTEM: ACTIVE

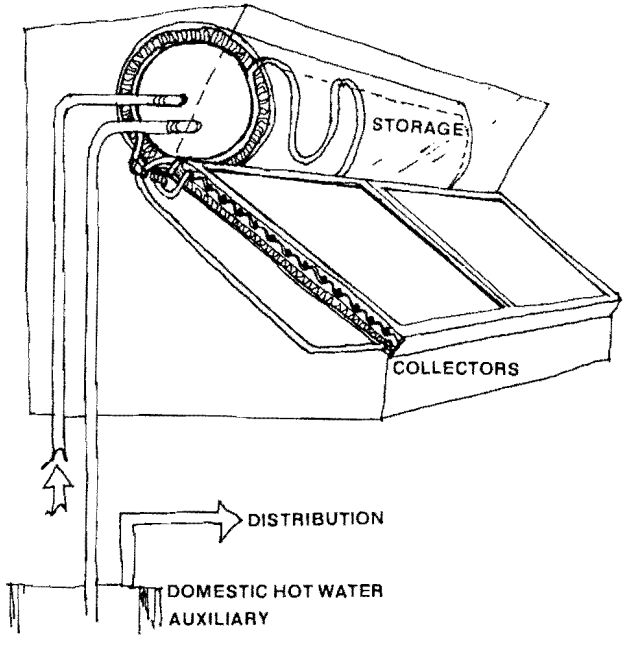
SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 64%

COLLECTOR: 80 sq. ft. of flat plate liquid collectors have been built by the applicant in a standoff mounting with reflectors above. Tilted 40°, the collectors are on the south facing roof of the 2 units. A water and propylene glycol solution transfers heat from the collector to a water storage tank via a contact plate heat exchanger.

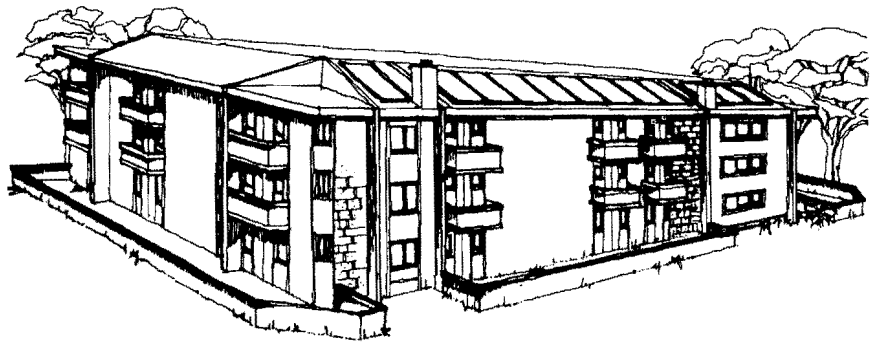
STORAGE: The heat exchanger, carrying heated liquid from the collectors, is wrapped around the lower third of a 55 gal. storage tank preventing any potable water contamination (Grumman system). The storage tank is located above the collector panels to allow thermo-syphoning to occur and eliminate the need for pumps. Cold water is fed by city pressure to the tank.

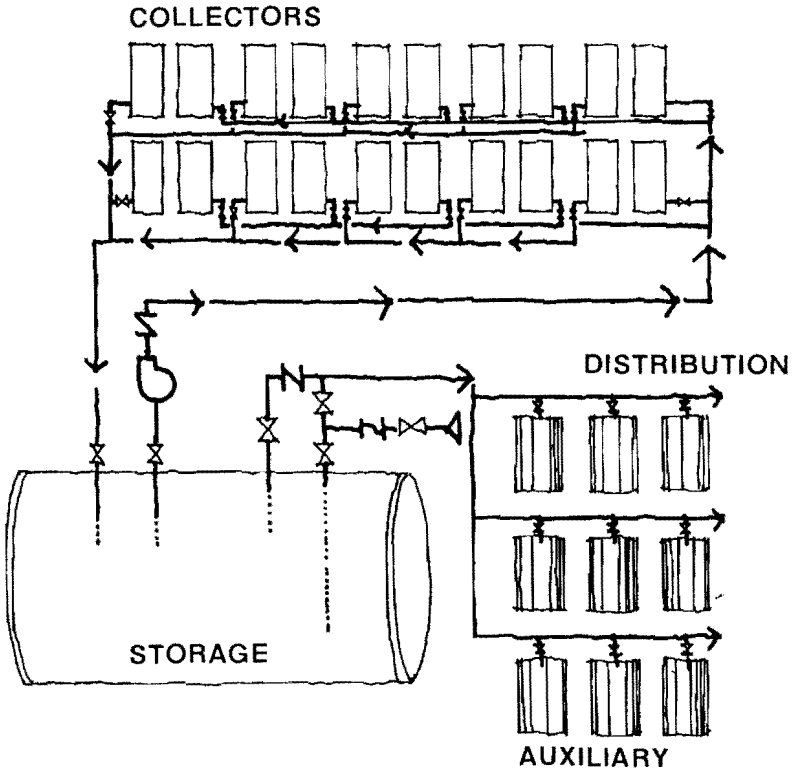
DISTRIBUTION: A gravity feed supplies domestic hot water directly from the roof top solar storage tank to the conventional hot water storage.

AUXILIARY ENERGY SYSTEM: A gas-fired conventional DHW storage provides 30,000 BTUH of backup energy.



PROJECT INFORMATION:
BUILDER/APPLICANT: Facilities Development Co.
DESIGNER: William H. Teer
SOLAR SUB: James L. Blakely, Inc.
LOCATION: San Diego, CA
LATITUDE: 32°40'N
HOUSING TYPE: MF Low, 31 Units
AREA: 1,100 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 1,507
COOLING HRS:
DESIGN TEMP: WINTER: 43° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 927 BTU/ft²
% SUN/YR: 82%





BUILDING DESCRIPTION/ENERGY CONCERNS

This project involves a new garden apartment building with 31 units. It has been designed to include a communal solar domestic hot water system, with collectors mounted on the pitched roof and storage buried adjacent to the apartment building.

SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 60%

COLLECTOR: The collector for this solar hot water system is manufactured by Revere and is mounted at an angle of 32° facing south. The area of the collector is 481.6 sq. ft., and potable water is used to transfer the heat to storage.

STORAGE: A 1,050 gallon water storage tank is buried adjacent to the building.

DISTRIBUTION: City water pressure forces preheated water from the top of the storage tank to individual hot water heaters in each apartment.

AUXILIARY ENERGY SYSTEM: The individual apartments use the conventional electric hot water heater as an auxiliary and backup system.

HAWAII

0 DD

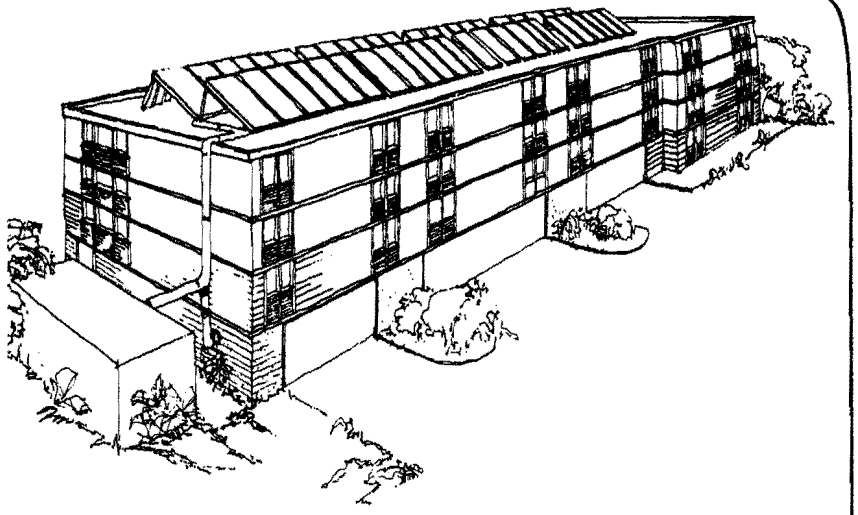
MF LOW RETRO

ACTIVE DHW

78

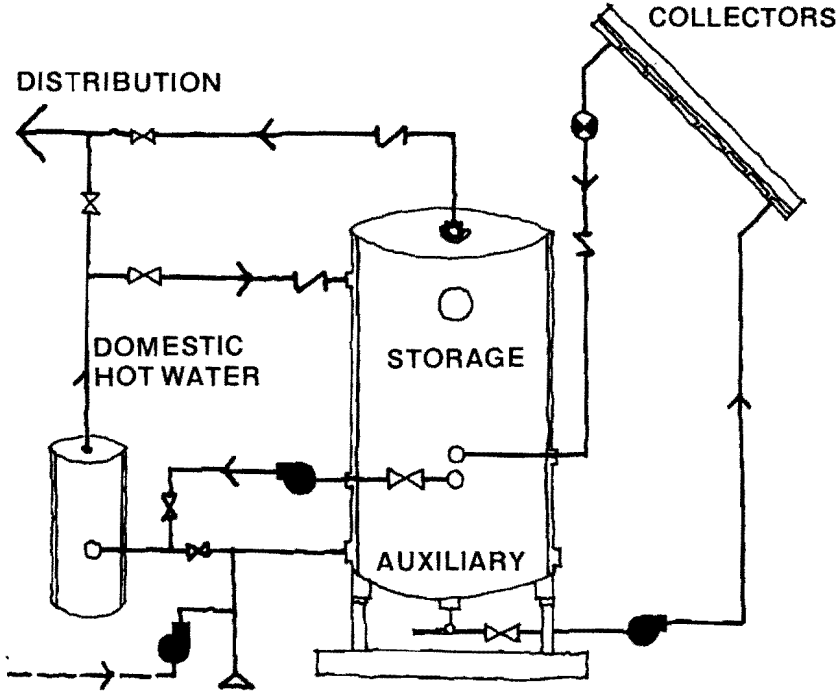
PROJECT INFORMATION:

BUILDER/APPLICANT: Hawaii Housing Authority
DESIGNER: Robert Helg, Architect
SOLAR SUB:
LOCATION: Waipahu, HI
LATITUDE: 21°N
HOUSING TYPE: MF Low, 19 Units
AREA: 625-805 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 0 DD
COOLING HRS:
DESIGN TEMP: WINTER: 72° F
SUMMER: 80° F
HORIZ. INSOL. JAN. DAY: 1,320 BTU/ft²
% SUN/YR: 65%



BUILDING DESCRIPTION/ENERGY CONCERNS

This existing 4 story multi-family apartment building houses 19 units with 2 or 3 bedrooms and 625 or 805 sq. ft. In this mild climate, neither heat loss or heat gain is a big design factor, except for the constant sunshine which is shut out by overhangs on the southern exposure.



SOLAR ENERGY SYSTEM: ACTIVE

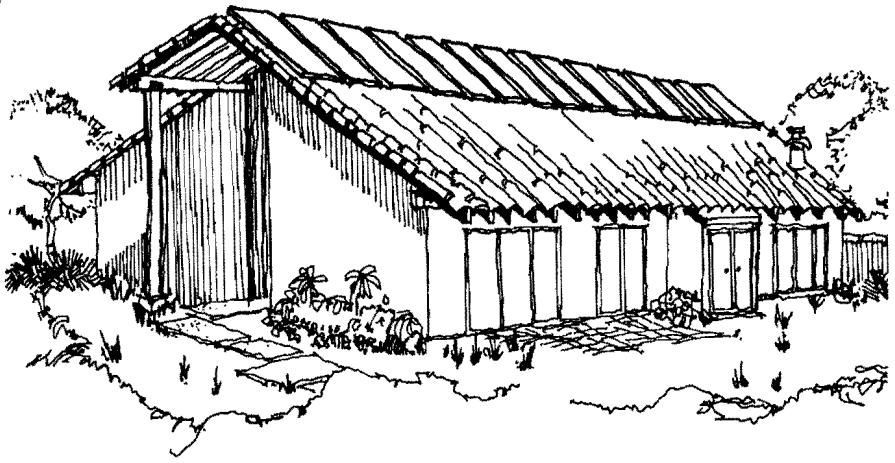
SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 100%

COLLECTOR: 800 sq. ft. of Raypak flat plate liquid collectors have been rack mounted, at a 24° tilt south, on the flat roof of this existing apartment building. Water is the heat transfer medium.

STORAGE: A solar circulator pump forces city water through the collectors and then to a 1,375 gallon storage tank located adjacent to the building.

DISTRIBUTION: A second pump brings heated water to the individual units.

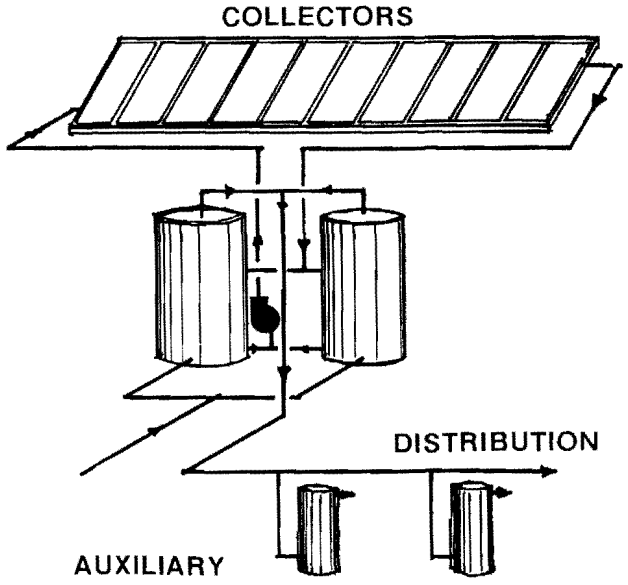
AUXILIARY ENERGY SYSTEM: Auxiliary and backup energy is provided by the existing 75 gallon, gas-fired, DHW heater. This can provide 360,000 BTUH of total backup energy.



PROJECT INFORMATION:
BUILDER/APPLICANT: Michael Corbett
DESIGNER: Michael Corbett
SOLAR SUB: Natural Heating Systems
LOCATION: Davis, CA
LATITUDE: 30°30'N
HOUSING TYPE: MF Low, 10 Units
AREA: 810 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 2,819
COOLING HRS:
DESIGN TEMP: WINTER: 30° F
SUMMER: 99° F
HORIZ. INSOL. JAN. DAY: 738 BTU/ft²
% SUN/YR: 75%

BUILDING DESCRIPTION/ENERGY CONCERNS

This project involves 10 garden apartments with a retrofit solar hot water system. Each unit has 810 sq. ft. of living area. In order to conserve energy large overhangs shield the south and west walls from summer heat gain. Also, fewer windows are located on the east and west walls to minimize winter heat loss and summer heat gain.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 59%

COLLECTOR: 360 sq. ft. of the flat plate collectors, manufactured by Sunburst, are located on the roof facing due south, at a tilt of 22.6°. Water is used to transport collected heat to storage.

STORAGE: Two steel tanks forming a 535 gallon storage capacity are located in the basement. A pump circulates the water through the collectors and then back to storage.

DISTRIBUTION: Preheated water is transported to a conventional hot water system for distribution.

AUXILIARY ENERGY SYSTEM: Auxiliary heat is provided by the gas-fired conventional system with a capacity of 320,000 BTUH.

CALIFORNIA
2819 DD
MF LOW RETRO
ACTIVE DHW
79

CALIFORNIA

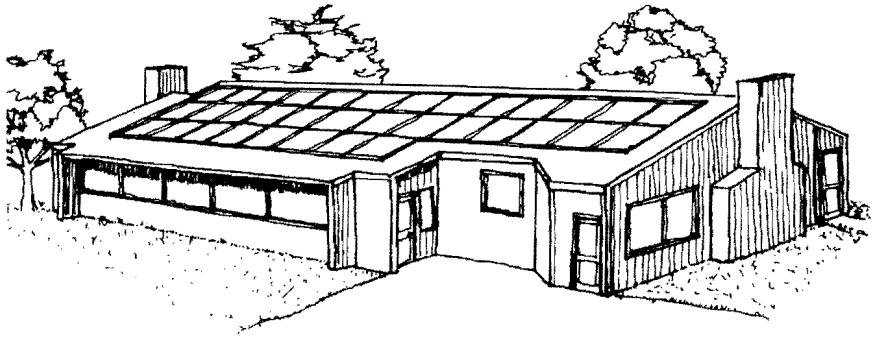
2969 DD

MF LOW RETRO

ACTIVE DHW

PROJECT INFORMATION:

BUILDER/APPLICANT: Colorado Park Housing Corp.
DESIGNER: Norman E. Rees
SOLAR SUB: Western Energy, Inc.
LOCATION: Palo Alto, CA
LATITUDE: 37°30'N
HOUSING TYPE: MF Low, 60 Units
AREA:
CLIMATIC DATA:
HEATING DD: 2,969
COOLING HRS:
DESIGN TEMP: WINTER: 34° F
SUMMER: 88° F
HORIZ. INSOL. JAN. DAY: 650 BTU/ft²
% SUN/YR: 75%



BUILDING DESCRIPTION/ENERGY CONCERNS

This community building of a 60 unit multi-family garden apartment complex has been retrofitted to include a solar DHW system with roof mounted collectors and a central storage tank within.

SOLAR ENERGY SYSTEM: ACTIVE

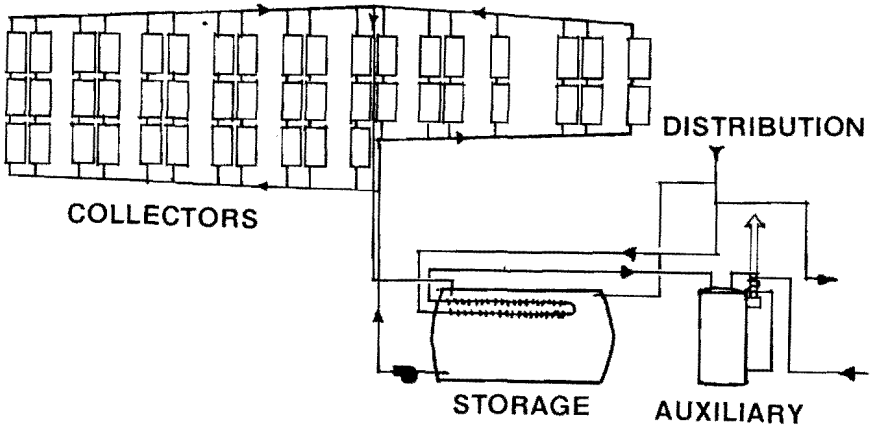
SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 38%

COLLECTORS: 1,034 sq. ft. of Western Energy, Inc. flat plate collectors have been directly mounted to the south facing 22° sloped roof of the community building. Potable water is run through the collectors to solar storage, so the drain down method is used to prevent freezing in the collector circuit.

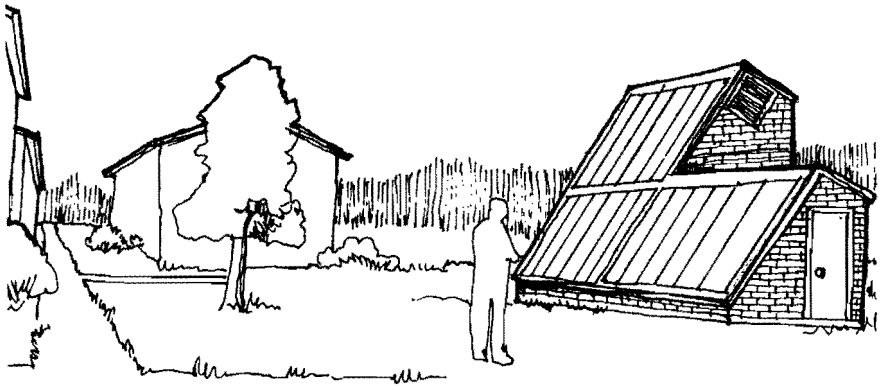
STORAGE: 1,963 gal. of water storage is located in a tank in the community facilities building, directly below the solar collectors.

DISTRIBUTION: Water is taken through a copper tubing heat exchange coil submerged directly in storage, for DHW preheat, before distribution to an existing 65 gal. DHW heater.

AUXILIARY: The conventional 65 gal. gas-fired DHW heater, along with the gas-fired central boiler, provides the auxiliary and backup energy for the DHW system.



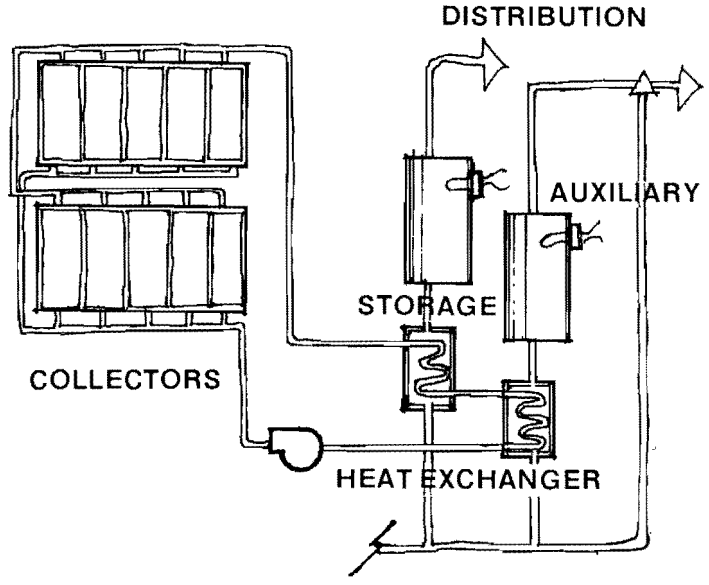
80



PROJECT INFORMATION:
BUILDER/APPLICANT: Greenfield Housing Authority
DESIGNER: Dirks Associates, Inc.
SOLAR SUB: IMS Contractors, Inc.
LOCATION: Greenfield, MA
LATITUDE: 42°35'N
HOUSING TYPE: MF Low, 16 Units
AREA: 545 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 5,715
COOLING HRS:
DESIGN TEMP: WINTER:
SUMMER:
HORIZ. INSOL. JAN. DAY: 429 BTU/ft²
% SUN/YR: 57%

BUILDING DESCRIPTION/ENERGY CONCERNS

A solar DHW system, supported by a separate mechanical building, is being added to the site of existing multi-family garden apartment housing for the elderly. These apartments are each 1 bedroom and encompass an area of approximately 545 sq. ft.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 52%

COLLECTOR: 227.5 sq. ft. of flat plate Sunworks collectors have been integrally mounted at a 60° tilt due south on the roof of the separate solar collector building. Water and antifreeze are pumped through the collector to a copper heat exchanger in each of the six 65 gal. storage tanks.

STORAGE: Located under the collector in the new solar building, storage consists of 390 gal. of water storage in the form of six 65 gal. water tanks.

DISTRIBUTION: Solar heated water is pumped to existing 120 gal. hot water tanks and then to the individual units.

AUXILIARY ENERGY SYSTEM: Auxiliary and backup is provided by the 4 existing electric DHW heaters of 120 gal. each.

MASSACHUSETTS
5715 DD
MF LOW NEW
ACTIVE DHW
81

HAWAII

0 DD

NEW

MF MID

ACTIVE DHW

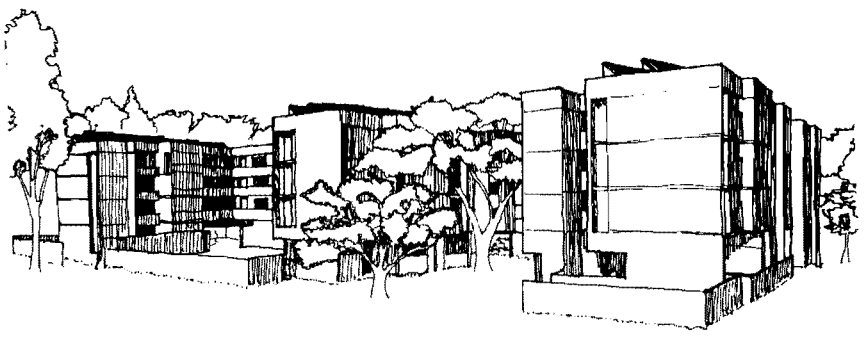
82

PROJECT INFORMATION:

BUILDER/APPLICANT: Hei Wei Wong
DESIGNER: Milton Sher, Architect
SOLAR SUB: The Cody Co., Inc.
LOCATION: Honolulu, HI
HOUSING TYPE: MF Mid, 55 Units
CLIMATIC DATA:
HEATING DD: 0 DD
DESIGN TEMP: WINTER: 72° F
HORIZ. INSOL. JAN. DAY: 1,320 BTU/ft²

LATITUDE: 21°N
AREA: 625 sq. ft./unit

COOLING HRS:
SUMMER: 80° F
% SUN/YR: 65%



BUILDING DESCRIPTION/ENERGY CONCERNS

In this project, 55 units of multi-family housing are located in 3 wings of 4-story elevator apartments. The first wing has 27 units, with 7 units and a laundry in the central wing, and 21 more units in the third wing. As energy conserving features, the buildings are oriented facing south-southwest, giving a maximum of southern and southwest exposures. Windows have been set in under overhangs to give a certain amount of shading from the high summer sun.

SOLAR ENERGY SYSTEM: ACTIVE

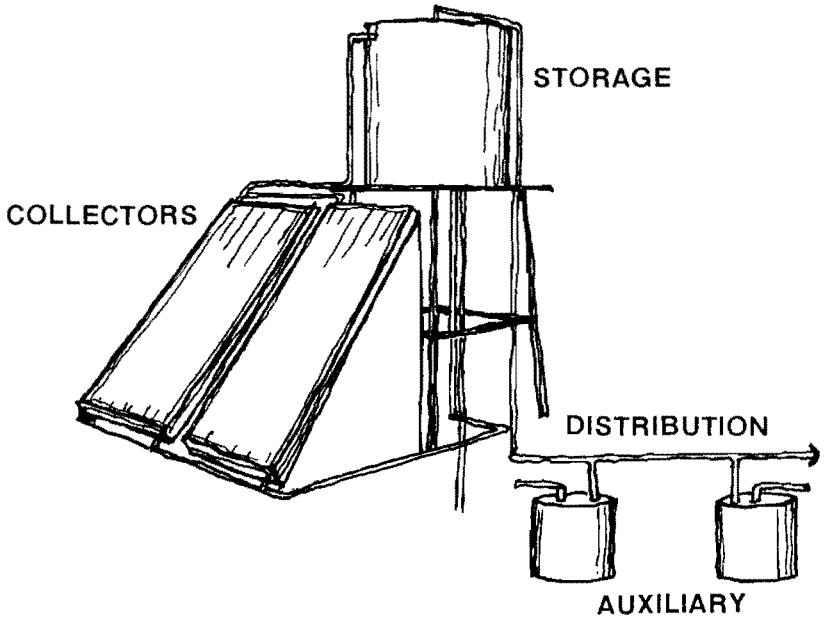
SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 100%

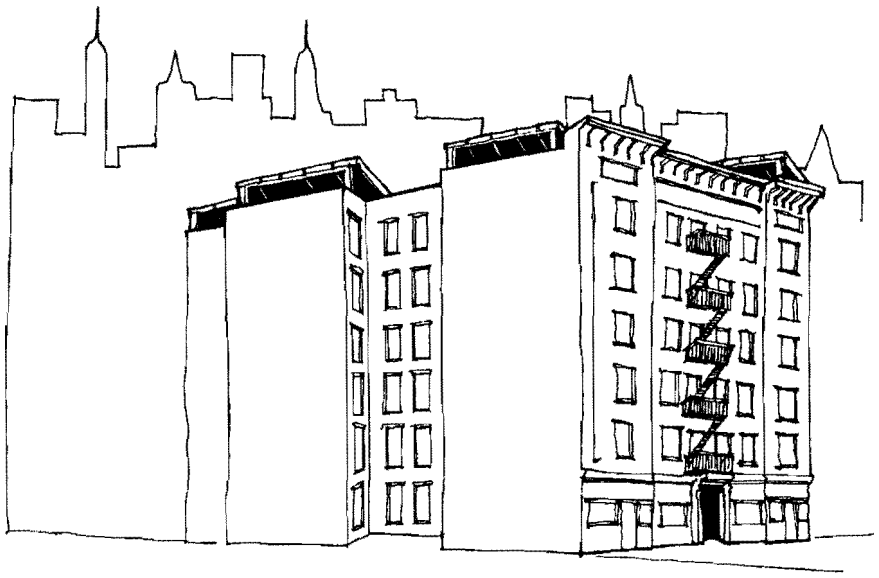
COLLECTORS: 2,523 sq. ft. of collectors, approximately 45 sq. ft./unit with 500 sq. ft. supplying the laundry hot water, are rack mounted at 24° facing south on the flat roofs. The collectors are manufactured by Raypak Inc., and use water as the heat transfer medium.

STORAGE: 1,825 gal., 1,230 gal. and 1,330 gal. of water are located above the collectors, allowing water pressure and thermosyphoning to transport the DHW through the collector circuit.

DISTRIBUTION: Hot water flow to the house is gravity fed from the top part of the storage tank to 30 gal. electric HW heaters shared jointly by every 3 apartments.

AUXILIARY ENERGY SYSTEM: An electric resistance coil in the conventional DHW tank supplies auxiliary heat. This system, however, is not meant to provide full backup capacity.



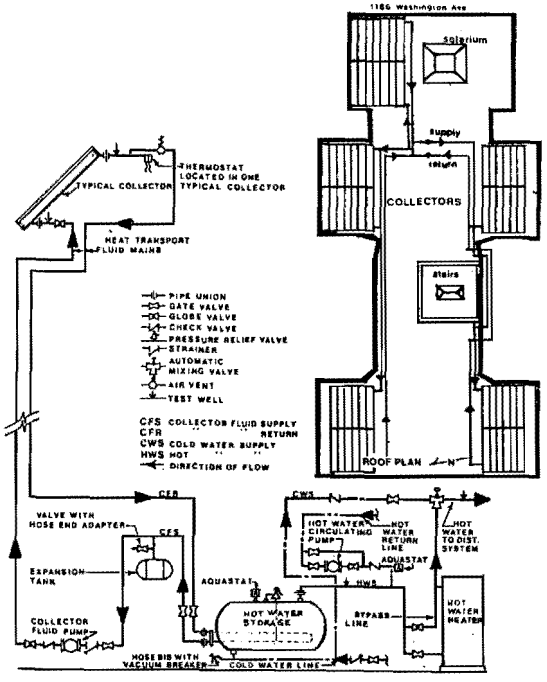


PROJECT INFORMATION:
BUILDER/APPLICANT: Peoples Development Corp.
DESIGNERS: Energy Task Force
SOLAR SUB: Sun Harvester Corp.
LOCATION: Bronx, NY
HOUSING TYPE: MF Mid. 28 Units
CLIMATIC DATA:
HEATING DD: 4,811
DESIGN TEMP: WINTER: 15° F
HORIZ. INSOL. JAN. DAY: 481 BTU/ft²

LATITUDE: 41°N
AREA:
COOLING HRS:
SUMMER: 91° F
% SUN/YR: 58%

BUILDING DESCRIPTION/ENERGY CONCERNS

This multi-family midrise is an existing building with 28 residential units. Energy conservation concerns include the addition of batt and rigid insulation to all walls and ceilings, as well as adding storm windows throughout.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 89%

COLLECTORS: 1,250 total sq. ft. of flat plate fluid collectors are rack mounted on the roof of this existing midrise building. Manufactured by Sun Harvester Corp., the collectors are south facing and placed on a 40° tilt.

STORAGE: A 40% propylene glycol solution transports solar heat through a shell and tube heat exchanger to transfer heat to 1,400 gal. of water storage. The 1,400 gal. HW tank is located centrally in the basement of the midrise.

DISTRIBUTION: City cold water supply can pass directly through the shell and tube heat exchanger for heating on its way to the living unit, or can be preheated and placed in solar storage for later use.

AUXILIARY ENERGY SYSTEM: An oil fired 225 gal. DHW heater provides 190,000 BTUH of auxiliary energy, and is located adjacent to the solar hot water storage.

NEW JERSEY

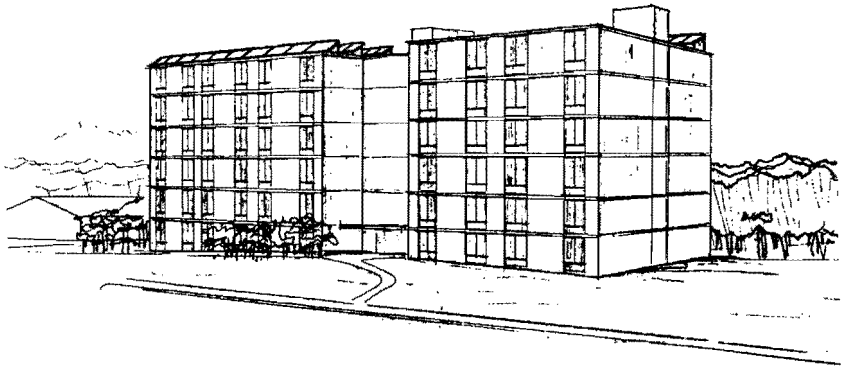
4980 DD

MFMD RETRO

ACTIVE DHW

84

PROJECT INFORMATION:
BUILDER/APPLICANT: Dover Housing Authority
DESIGNER: Raymond Heinrich, Architect
SOLAR SUB: American Solar Companies, Inc.
LOCATION: Dover, NJ
LATITUDE: 40°55'N
HOUSING TYPE: MF Mid, 61 units
AREA: 550 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 4,980
COOLING HRS:
DESIGN TEMP: WINTER: 6° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 553 BTU/ft²
% SUN/YR: 62%



BUILDING DESCRIPTION/ENERGY CONCERNS

This retrofit project involves an existing six story apartment building for the elderly. Energy conserving features include the closing of all east and west walls into party walls, or exterior end walls with minimum openings, to reduce summer heat gain and winter heat loss. The length of the building is oriented to the south, for optimal sun exposure.

SOLAR ENERGY SYSTEM: ACTIVE

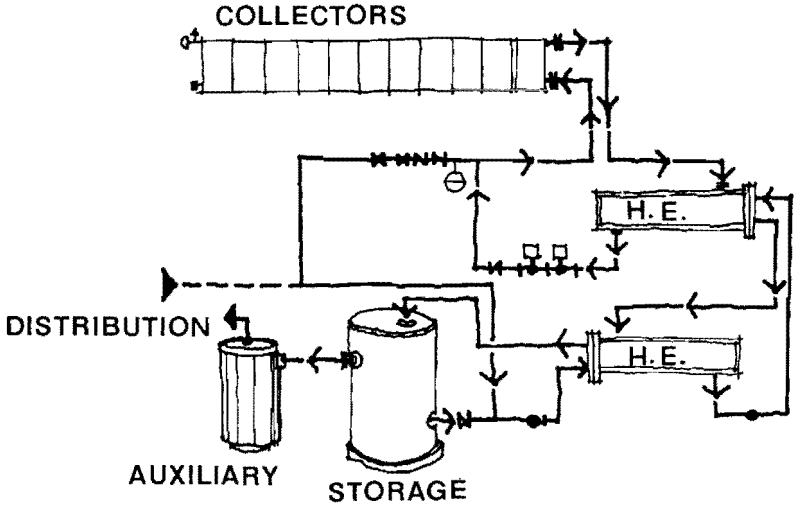
SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 58.4%

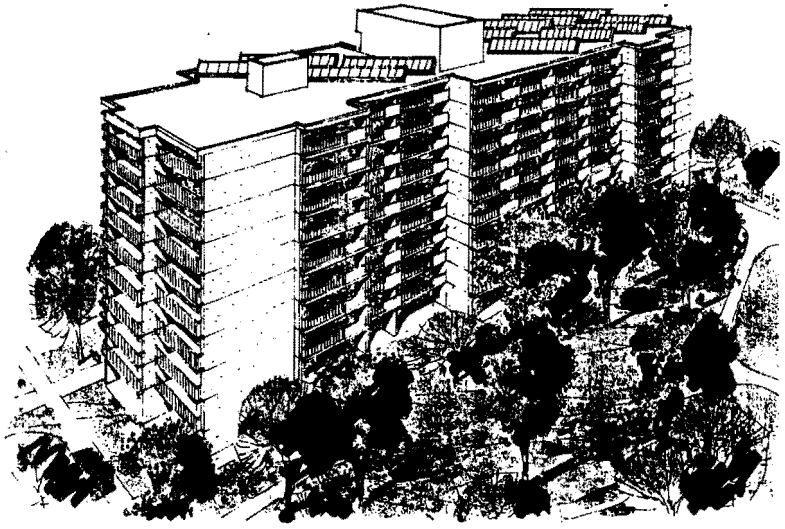
COLLECTOR: There are 1,420 sq. ft. of flat plate collectors rack mounted on the roof of the building, facing due south at a 45° tilt. They are manufactured by the Daystar Corporation. Two shell and tube heat exchangers extract the heat which is collected in a glycerol/water solution and transfer it to potable water.

STORAGE: A 2,500 gallon water tank located on the first floor provides storage for the solar system.

DISTRIBUTION: Conventional DHW distribution.

AUXILIARY ENERGY SYSTEM: A conventional hot water heater provides 140° water for total back up supply.

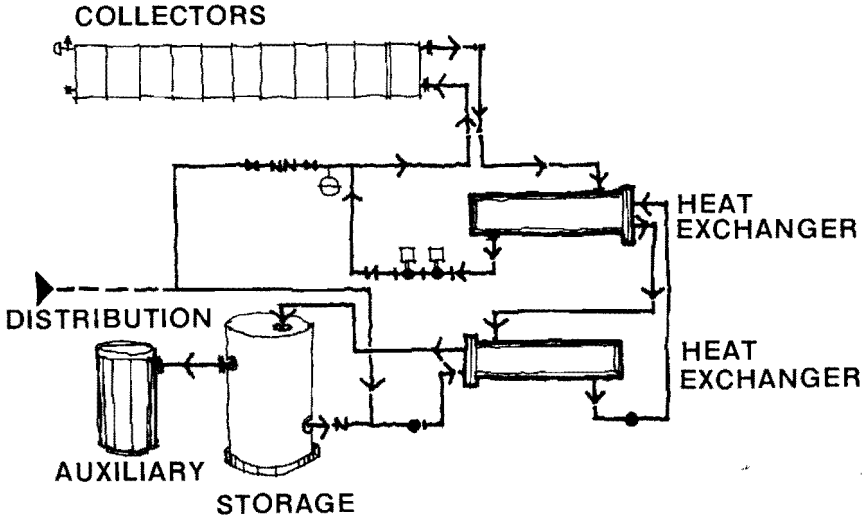




PROJECT INFORMATION:
BUILDER/APPLICANT: Forest City Dillon Inc.
DESIGNER: Andrew Bryant & Associates
SOLAR SUB: Solar Resources, Inc.
LOCATION: Washington D.C. **LATITUDE:** 39°N
HOUSING TYPE: MF High, 188 Units **AREA:** 660 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 4,600 COOLING HRS:
DESIGN TEMP: WINTER: 15° F SUMMER: 91° F
HORIZ. INSOL. JAN. DAY: 654 BTU/ft² % SUN/YR: 66%

BUILDING DESCRIPTION/ENERGY CONCERNS

188 units of new 1 bedroom apartments are being provided in a 124,000 sq. ft. high rise building.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 69%

COLLECTOR: 2,220 total sq. ft. of Lennox-Honeywell flat plate collectors have been rack mounted on the roof of this multi-family highrise. The collectors have been placed at a 40° tilt facing south. A 50% ethylene-glycol solution is pumped through the collectors, absorbing heat, and taken through a shell and tube heat exchanger.

STORAGE: 3,200 gal. of water are centrally located for solar heat storage. Cold water drawn from the bottom of storage absorbs heat in the heat exchanger and is fed to the center of storage, displacing the hottest water at the top of storage into several conventional DHW boilers for house demand.

DISTRIBUTION: DHW supply is then drawn from the conventional DHW boilers.

AUXILIARY ENERGY SYSTEM: The oil fired hot water boilers provide 760,000 BTUH of back-up energy.

WASHINGTON, D.C. 4600 DD MF HIGH NEW ACTIVE DHW

85

GEORGIA

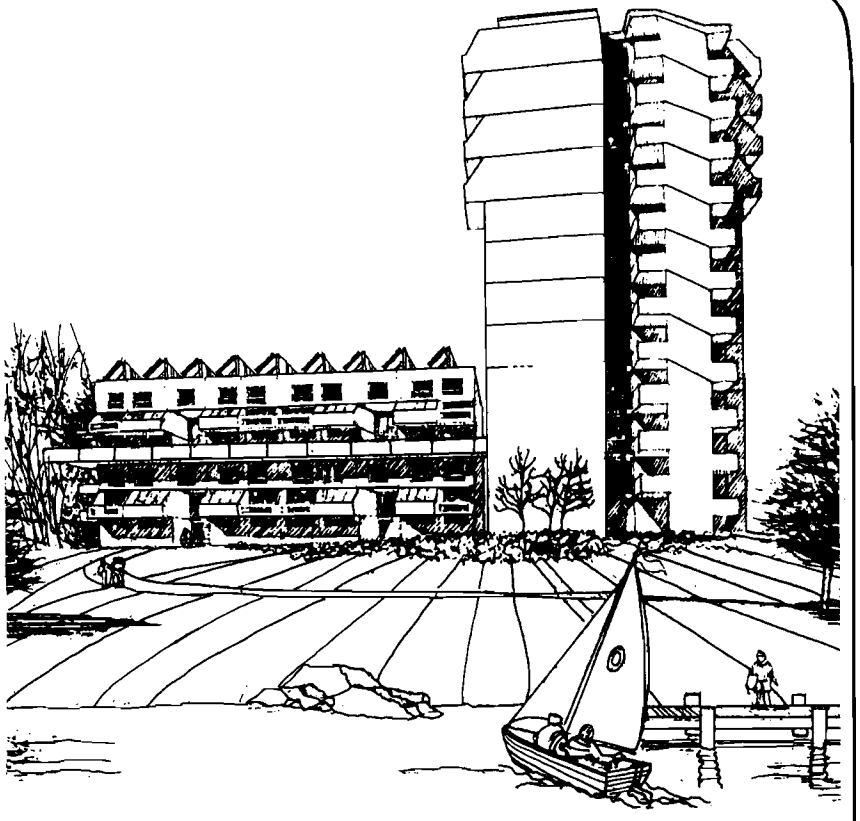
2136 DD

MF HIGH & MID NEW

ACTIVE DHW

86

PROJECT INFORMATION:
BUILDER/APPLICANT: Kenilworth Manor Inc.
DESIGNER: Arthur D. Brook, P.E.
SOLAR SUB: Piping Contractors
LOCATION: Macon, GA
LATITUDE: 32°N
HOUSING TYPE: MF Mid & High, 80 Units
AREA: 805-1,477 sq.ft./unit
CLIMATIC DATA:
HEATING DD: 2,136
COOLING HRS:
DESIGN TEMP: WINTER: 27° F
SUMMER: 96° F
HORIZ. INSOL. JAN. DAY: 900 BTU/ft²
% SUN/YR: 63%



BUILDING DESCRIPTION/ENERGY CONCERNS

This application includes two existing multi-family buildings. One is a highrise with 56 one or two bedroom units of 805-1,044 sq. ft. each; the second is a midrise with 24 two or three bedroom units of 1,094-1,477 sq. ft. per unit.

SOLAR ENERGY SYSTEM: ACTIVE

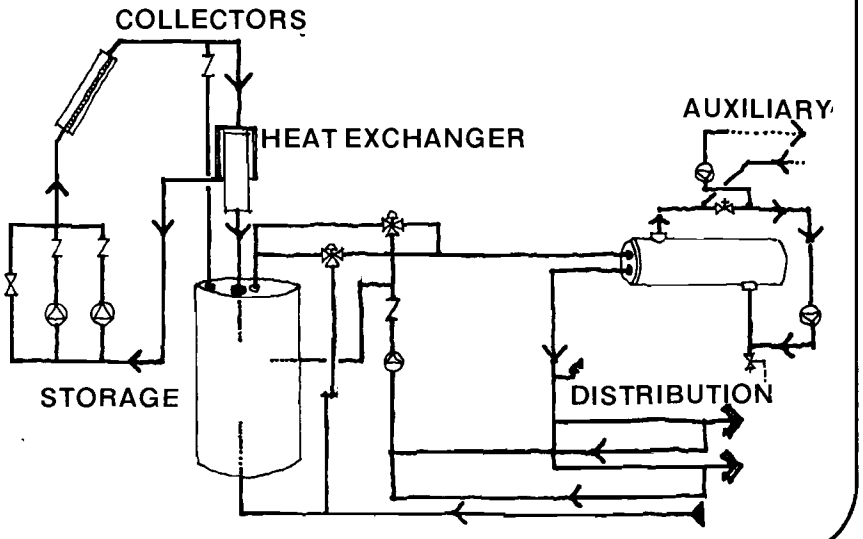
SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 78%

COLLECTOR: 2,167 sq. ft. of Revere flat plate liquid collectors are rack mounted on the roof of the low rise building, giving 27 sq. ft. of collector for each of the 80 units. The collectors are oriented 44° west of south at a 60° tilt. Water is pumped through the collector, absorbs solar radiation, and carries the solar heat to a shell and tube heat exchanger, which transfers the heat to the potable water in storage. The drain down method is used to prevent freezing in the circuit in winter.

STORAGE: 3,000 gal. of water are kept preheated in a storage to heat exchanger loop and are stored in a steel tank with 9" of insulation. The tank is located outside, above ground, and adjacent to the buildings.

DISTRIBUTION: Hot water is drawn from storage and taken to an existing auxiliary energy tank for an energy boost, then it is delivered to the living unit.

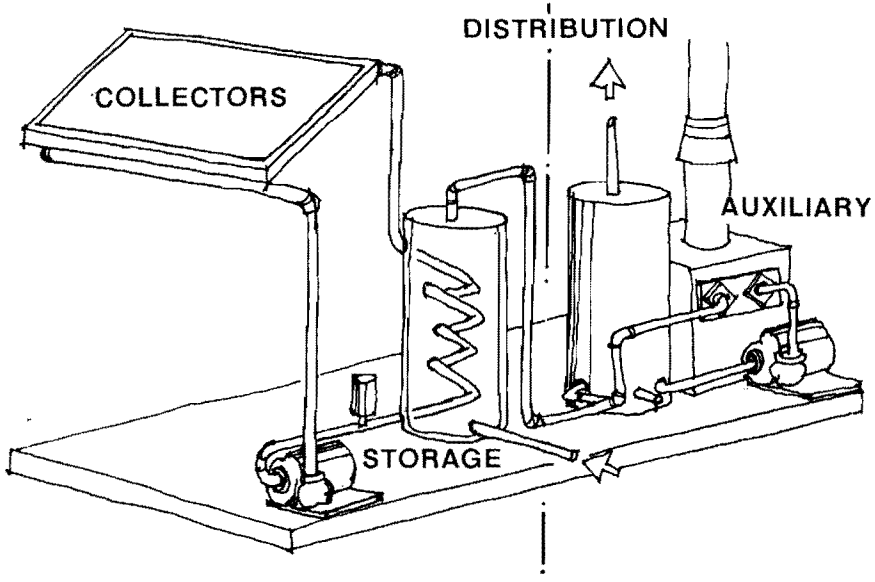
AUXILIARY ENERGY SYSTEM: An existing gas fired boiler provides 4,800,000 BTUH or 100% back-up energy.



PROJECT INFORMATION:
BUILDER/APPLICANT: Battle Creek Housing Commission
DESIGNER: Environmental Energies, Inc.
SOLAR SUB: Environmental Energies, Inc.
LOCATION: Battle Creek, MI — **LATITUDE:** 42°20'N
HOUSING TYPE: MF High, 150 Units — **AREA:**
CLIMATIC DATA:
HEATING DD: 6,778 — COOLING HRS: 450
DESIGN TEMP: WINTER: 1° F — SUMMER: 92° F
HORIZ. INSOL. JAN. DAY: 450 BTU/ft² — % SUN/YR: 51%

BUILDING DESCRIPTION/ENERGY CONCERNS

This existing 9 story multi-family highrise includes 150 living units, and is being retrofitted for solar domestic hot water heating. The long face of the building optimally faces south, eliminating east and west exposures and facilitating solar collector positioning.



SOLAR ENERGY SYSTEM: ACTIVE

SOLAR APPLICATION: Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 85%

COLLECTOR: 1,100 sq. ft. of Sunworks flat plate liquid collectors are rack mounted on the flat roof at a 55° tilt, facing south A 50% propylene glycol solution is circulated through the collectors in winter and only water is circulated in summer. The heated fluid then transfers solar heat through a heat exchanger located in the water storage.

STORAGE: Two 1,000 gal. water storage tanks, wrapped in R-19 blanket insulation, are located in the basement of the highrise.

DISTRIBUTION: Preheated water is then mixed with regularly heated water in the adjacent existing DHW heater and taken to house demand.

AUXILIARY ENERGY SYSTEM: Gas fires the existing DHW heater providing 1,328,000 BTUH of back-up energy.

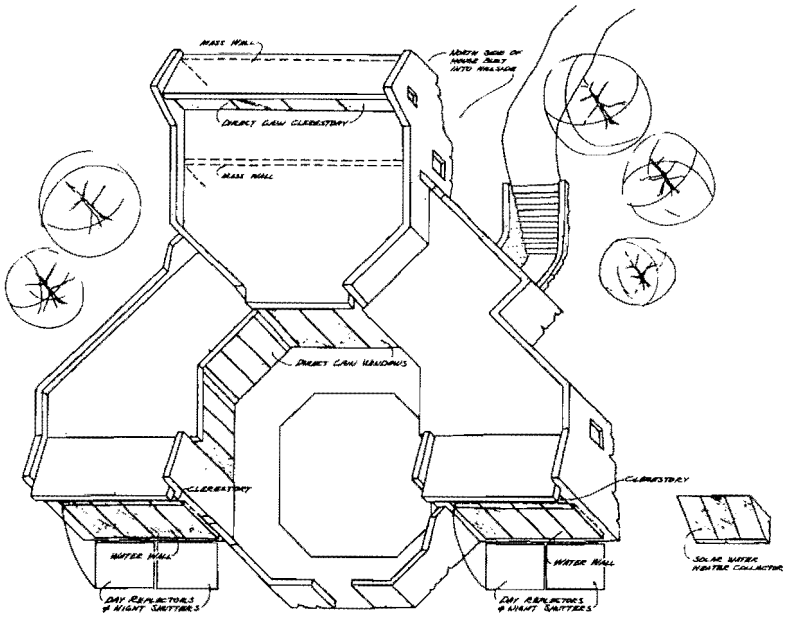
MICHIGAN
6778 DD
MF HIGH RETRO
ACTIVE DHW
87

PASSIVE HEATING & ACTIVE DHW 1 SFD NEW 5586 DD NEW MEXICO

88

PROJECT INFORMATION:

BUILDER/APPLICANT: Communico
DESIGNER: William Lumpkins
SOLAR SUB: Communico
LOCATION: Santa Fe, NM
LATITUDE: 35°N
HOUSING TYPE: SFD, 1 Unit
AREA: 2,200 sq. ft.
CLIMATIC DATA:
HEATING DD: 5,586
COOLING HRS:
DESIGN TEMP: WINTER: 11° F
SUMMER: 70° F
HORIZ. INSOL. JAN. DAY: 1,090 BTU/ft²
% SUN/YR: 76%



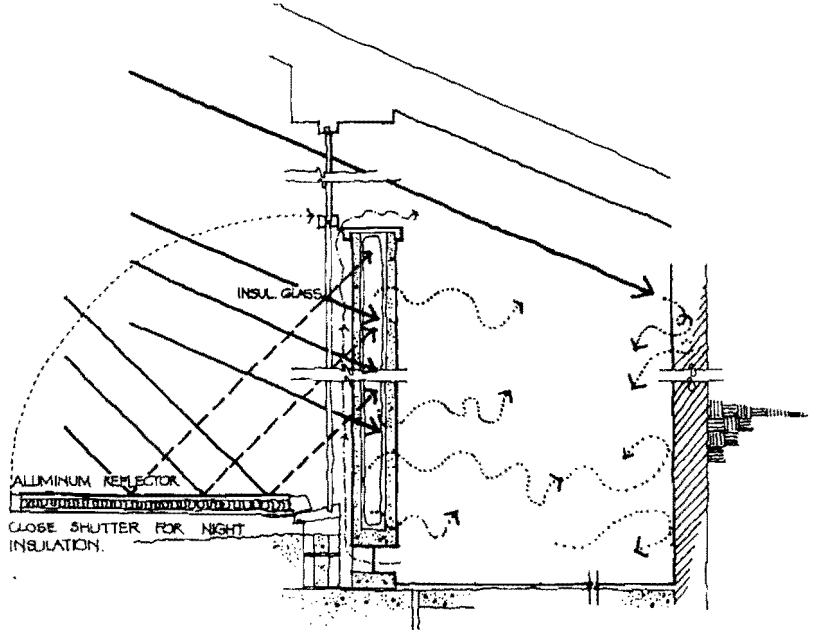
BUILDING DESCRIPTION/ENERGY CONCERNS

The walls of this single family home collect, store and radiate solar heat to the building. The house faces south, and the north wall is built into the hill to prevent convective heat losses. Windows with overhangs provide natural light without heat gain. Few openings are oriented east or west, except those facing the court, which are shaded in early morning and late day. A fireplace supplies an alternative heat source.

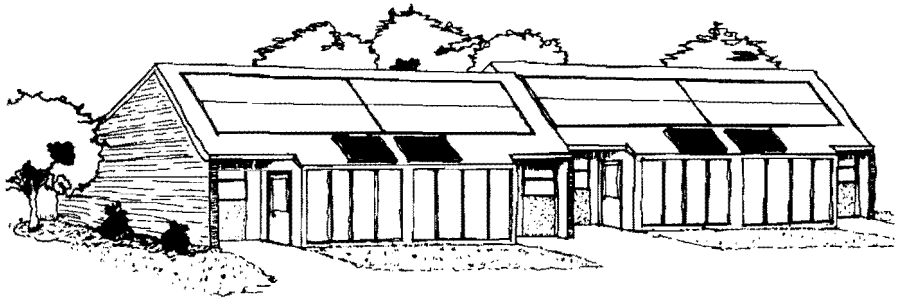
SOLAR ENERGY SYSTEM: PASSIVE

SOLAR APPLICATION: Passive Heating & Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 75%

PASSIVE SYSTEM: Massive walls on the south of two of the bedrooms collect solar heat, and store the heat in water bags within the walls. Glazing prevents the reradiation of heat to the outside. Additional Insulating panels are raised at night and, when lowered, serve as reflectors during the day. For distribution, air moves between the water mass wall and the glass, distributing heat by natural convection. The walls also radiate heat to the living space. The third bedroom and the living space are heated by sun entering clerestory windows and striking an interior heavy masonry wall, which stores the heat and radiates it after sundown. The space is also heated by direct gain, through windows permitting the sun to strike the floor and the objects, within. Back-up heat is provided by individual hydronic baseboard units thermostatically controlled for each room.



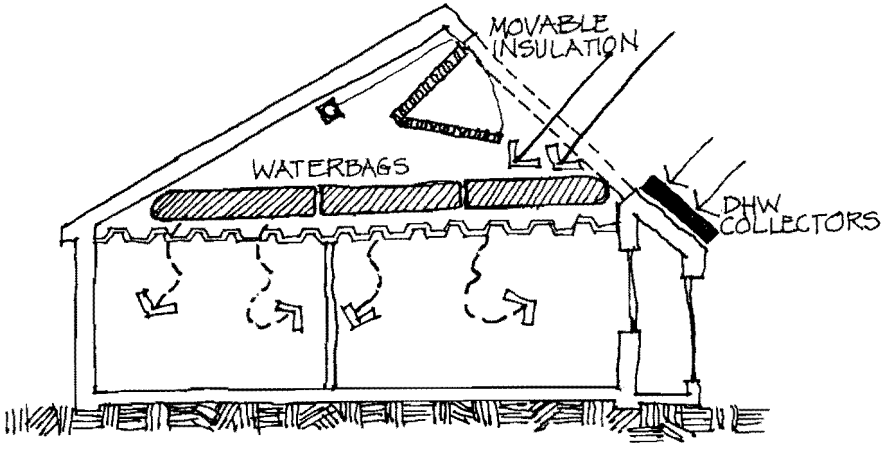
DOMESTIC HOT WATER SYSTEM: 33 sq. ft. of collector is located on the ground away from the building, and uses propylene glycol to transfer heat from the collectors through a heat exchanger to storage. Storage is comprised of a 40 gal. preheat tank, combined with a 40 gal. conventional DHW heater.



PROJECT INFORMATION:
BUILDER/APPLICANT: South Central Community Action Program, Inc.
DESIGNER: Associated Architects & Engineers
SOLAR SUB: Harold Hay/Skytherm
LOCATION: Lake Andes, SD
LATITUDE: 43°N
HOUSING TYPE: SFA, 4 Units
AREA: 540 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 7,133
COOLING HRS:
DESIGN TEMP: WINTER: −5° F
SUMMER: 90° F
HORIZ. INSOL. JAN. DAY: 680 BTU/ft²
% SUN/YR: 59%

BUILDING DESCRIPTION/ENERGY CONCERNS

This project consists of 4 single family attached homes with approximately 600 sq. ft. of space in each unit. In order to conserve energy, the units are oriented to the south, therefore closing off east and west faces to summer heat gain and winter heat loss. The north face has only minimal openings and the plan is organized with living spaces to the south where there are maximum window openings. This, along with a greenhouse on the south (which acts as an entry air lock), optimizes winter heat gain.



SOLAR ENERGY SYSTEM: PASSIVE AND ACTIVE

SOLAR APPLICATION: Passive Heating & Active Domestic Hot Water
PREDICTED SOLAR CONTRIBUTION: 98%

PASSIVE SYSTEM: Skytherm "thermoponds", filled with water, are located in the attic of each unit. Opening the Movable insulation in the roof structure exposes the ponds to the sun. Later the roof panels can be closed in order to retain the heat during nighttime hours. The thermoponds then store heat and distribute it to the house via conduction and radiation through the ceiling. Auxiliary heat is provided by an electric heater in each unit with a capacity of 30,000 BTUH.

DOMESTIC HOT WATER: Solar heat for the DHW system is provided by 114 sq. ft. of collector located on the roof of the greenhouse, facing south at a 45° tilt.

PASSIVE HEATING & ACTIVE DHW 4 SFA NEW 7133 DD S. DAKOTA

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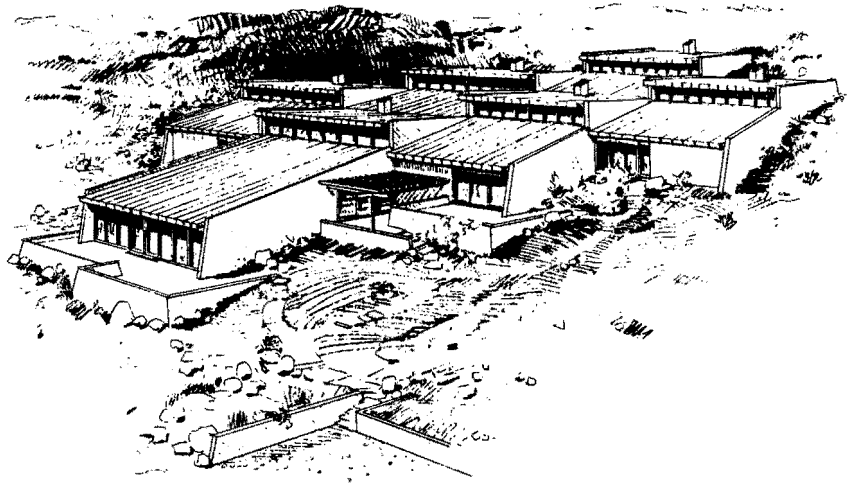
PROJECT INFORMATION:

BUILDER/APPLICANT: Herbert Kauffman
DESIGNER: Michael Frerking & George Allen
SOLAR SUB: Herbert Kauffman
LOCATION: Mayer, AZ — **LATITUDE:** 34°N
HOUSING TYPE: SFA, 5 Units — **AREA:** 1,160 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 3,324 — COOLING HRS:
DESIGN TEMP: WINTER: 31.4° F — SUMMER: 90° F
HORIZ. INSOL. JAN. DAY: 1,150 BTU/ft² — % SUN/YR: 85%



BUILDING DESCRIPTION/ENERGY CONCERNS

This project includes 5 attached units, each with 1,160 sq. ft. of living space. The efficiency units share a common livingroom, diningroom, and kitchen. The majority of north and west faces are set into the sloping land below grade for thermal optimization. Windows and skylights are placed for shade in the summer, and maximum sun in winter. Windows are double glazed and fixed with operable vents of 10% of the window area. Insulation is R38 in the ceiling.

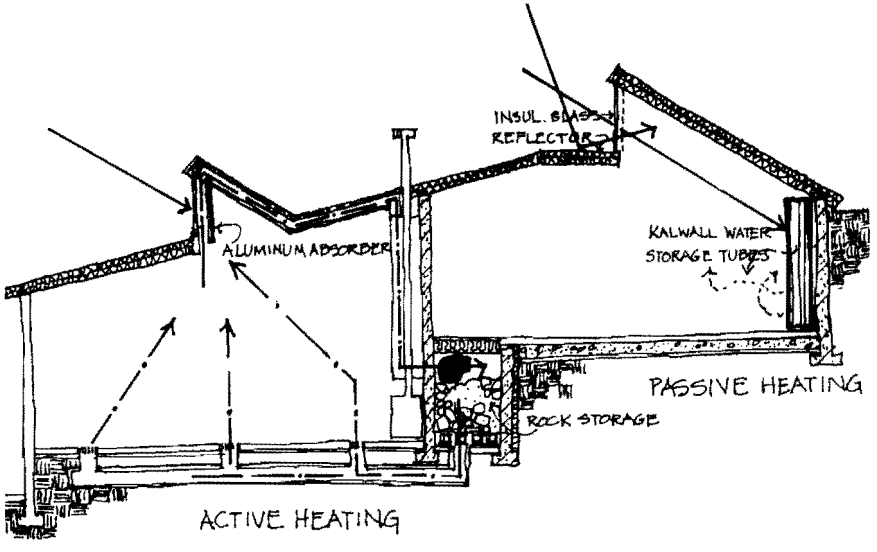
SOLAR ENERGY SYSTEM: HYBRID

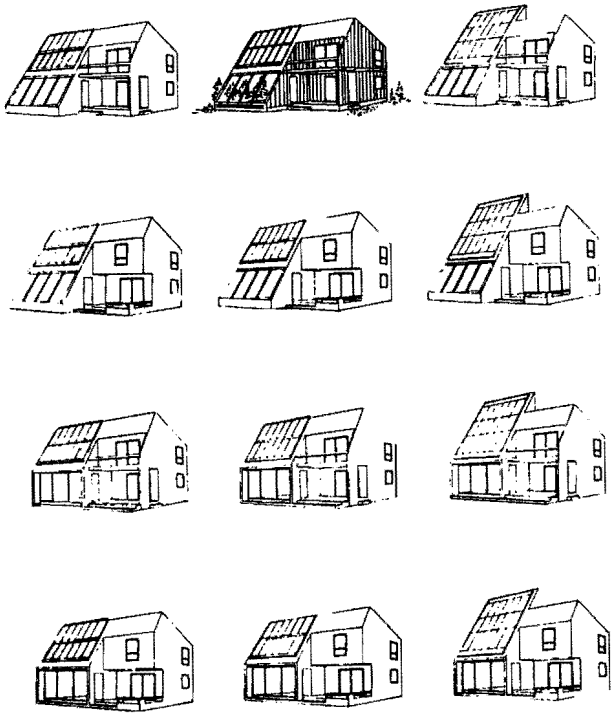
SOLAR APPLICATION: Active & Passive Heating, Active DHW
PREDICTED SOLAR CONTRIBUTION: 85-90%

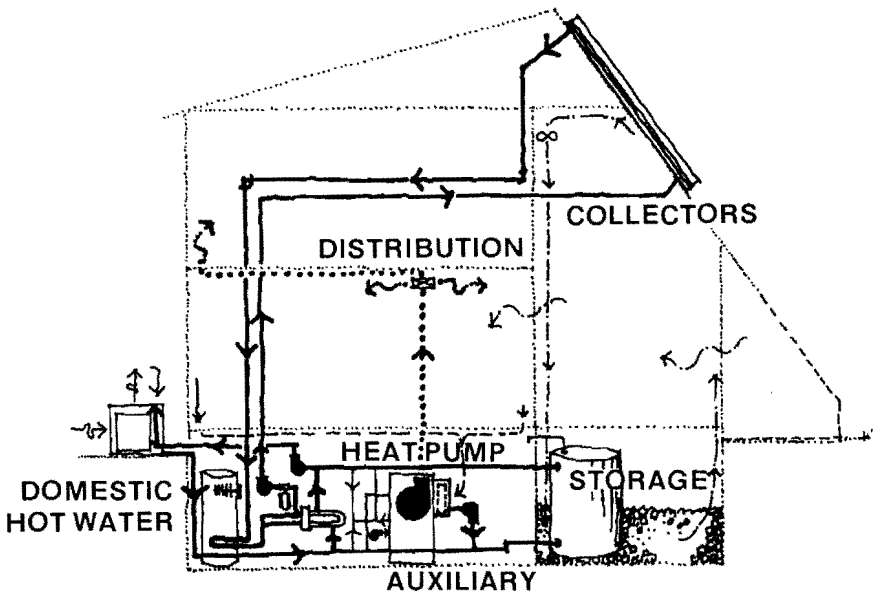
PASSIVE SYSTEM: Clerestory and regular windows facing due south act as solar collectors for these units. 4" thick floors and 8" thick masonry walls are combined with one ft. round Kalwall storage tubes to act as solar storage. Placed within reach of sunlight from the clerestories and windows, the 72 ft. of storage tubes, the slab and walls are calculated to provide approx. 36,000 BTUH, 33,600 BTUH and 47,255 BTUH respectively. Reradiation and convection are the methods of distribution. In addition, south facing windows provide 143,000 BTU/day.

ACTIVE SYSTEM: This system is set up to specifically heat the common living areas. Behind the clerestory over the living area, a corrugated aluminum absorber panel covers 70% of the glass area and acts as an active air system. A fan draws return air from the living area through this collector, down to a rock storage set into the sloped site adjacent to the livingroom. This storage provides for a hot air distribution. Ashley wood stoves in each room provide auxiliary heating energy as required.

DOMESTIC HOT WATER: In order to heat domestic hot water, another active solar system is used. Two panels of Sunsource flat plate liquid collectors are connected to an 82 gal. DHW heater. Water is circulated from the tank bottom, through the collectors, and returned to the top of storage. Warm water from the middle of storage is circulated to prevent freezing. An electric resistance element located in this DHW heater provides the auxiliary and back-up energy.







PROJECT INFORMATION:
BUILDER/APPLICANT: Oscar P. Wren
DESIGNER: Donald Watson
SOLAR SUB: Max Cochran
LOCATION: Tomaro Oaks, MO — **LATITUDE:** 37°N
HOUSING TYPE: SFD, 1 Unit — **AREA:** 1,304 sq. ft.
CLIMATIC DATA:
HEATING DD: 4,561 — COOLING HRS:
DESIGN TEMP: WINTER: 15° F — SUMMER: 96° F
HORIZ. INSOL. JAN. DAY: 700 BTU/ft² — % SUN/YR: 63%

BUILDING DESCRIPTION/ENERGY CONCERNS

A greenhouse contributes heat to this single family home with 3 bedrooms and 1,304 sq. ft. This unit is one in a series of prefabricated homes. The living spaces are located on the south side of the house while services and equipment are grouped on the north, aiding in thermal optimization. Glass doors on the south wall are recessed to shade from the summer sun. North glazing is high to vent summer heat gain. Minimum openings on the east and west faces lessen summer heat gain and winter heat loss. Good insulation is used throughout, and the entry forms an airlock.

SOLAR ENERGY SYSTEM: HYBIRD

SOLAR APPLICATION: Passive & Active Heating, & Active DHW
PREDICTED SOLAR CONTRIBUTION: 77%

PASSIVE SYSTEM: Heat that has been collected in the greenhouse is drawn from the upper part of the sunroom by a fan and taken to the rock storage surrounding the active system water storage. Cooler air is returned to the sunroom below the south facing windows. When the sunroom is opened to the rest of the house, radiant and convective heat is provided directly to the interior spaces.

ACTIVE SYSTEM: 223 sq. ft. of flat plate collectors are located on the roof facing 20° east of south at a 54° tilt. The collectors are manufactured by Sunworks. The liquid system uses propylene glycol as a transfer fluid which passes through a heat exchanger to transfer the collected heat to water storage. The storage is a 1,000 gal. water tank which sits in a rock bed under the house. In the summer, this storage combines with a heat pump to provide chilled water storage for the cooling system. To heat the living space from storage, a forced air system distributes the collected heat by passing air over a hot coil containing heated water from storage. This coil is located in the return air duct. Auxiliary heat source is a heat pump in the basement with a capacity of 44,500 BTUH.

DOMESTIC HOT WATER: In order to preheat domestic hot water, heated water from the collectors passes through a coil in the 65 gal. conventional electric hot water tank.

HYBRID HEATING & ACTIVE DHW 1 SFD NEW 4711 DD KANSAS

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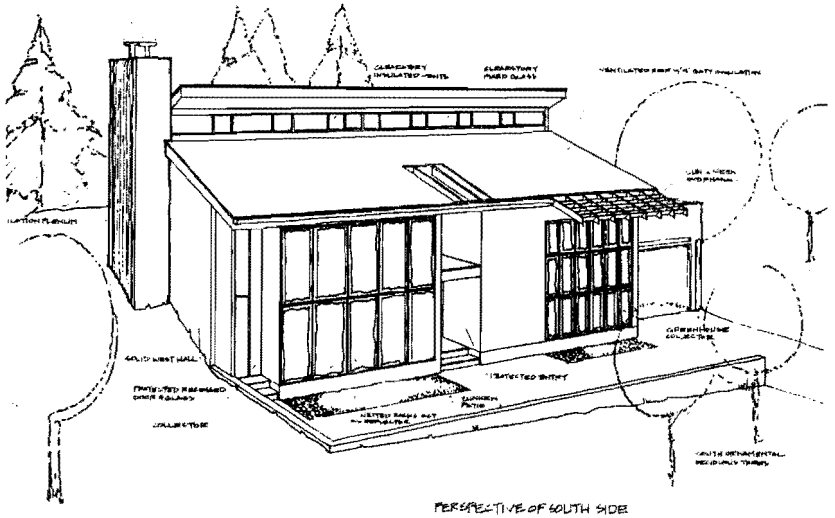
PROJECT INFORMATION:

BUILDER/APPLICANT: John C. Byram
DESIGNER: Vincent La Tona
SOLAR SUB: City Wide Heating & Cooling
LOCATION: Shawnee, KS
LATITUDE: 39°N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,675 sq. ft.
CLIMATIC DATA:
HEATING DD: 4,711
COOLING HRS:
DESIGN TEMP: WINTER: 8° F
SUMMER: 94° F
HORIZ. INSOL. JAN. DAY: 720 BTU/ft²
% SUN/YR: 63%

BUILDING DESCRIPTION/ENERGY CONCERNS

This three bedroom house has 1,675 sq. ft. of living space. Energy conserving features include a greenhouse, to provide direct solar heating as well as an efficient thermal buffer. The entry is protected and deep overhangs shade south facing windows from direct summer heat gain. Evergreens serve as a windbreak to the north, while deciduous trees to the south provide shade in summer. A clerestory skylight provides natural light and ventilation. A patio and rockbed on the southern side reflects additional radiation to the active and passive collectors.



PERSPECTIVE OF SOUTH SIDE

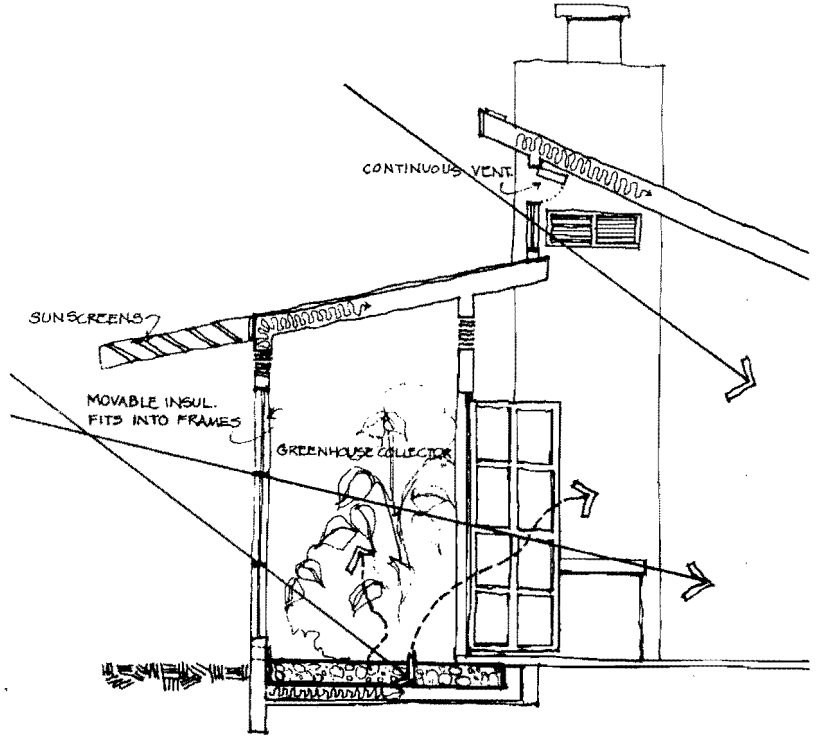
SOLAR ENERGY SYSTEM: HYBIRD

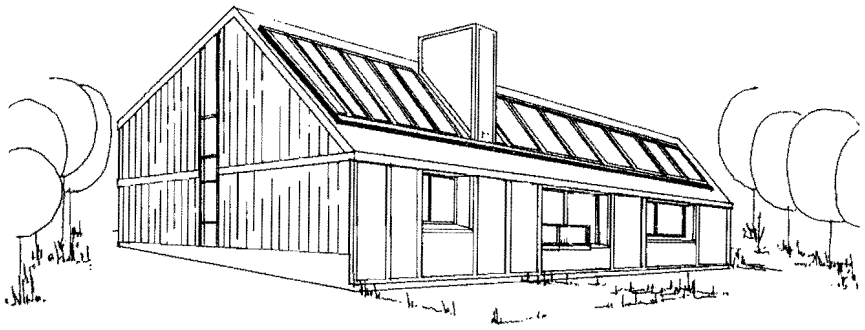
SOLAR APPLICATION: Active & Passive Heating, Active DHW
PREDICTED SOLAR CONTRIBUTION: 60%

PASSIVE SYSTEM: For passive solar heating, the south-facing greenhouse has a dark aggregate floor which absorbs and stores solar heat. Movable insulation prevents heat loss to the outside, or can be closed to prevent heat gain from the summer sun. Vents are also provided to prevent overheating. A solar ventilation plenum is integrated with the chimney on the west wall; through a series of dampers, the plenum takes advantage of convective currents created by the sun on the wall to provide natural ventilation.

ACTIVE SYSTEM: 195 sq. ft. of Solaron flat plate collectors are mounted vertically on the south wall. Air is circulated through the collectors and transports heat to 97.5 cu. ft. of river rock stored in the basement. This storage has a capacity of 136,000 BTUH. The heated air is then blown through an air handling unit which directs air to the ductwork in the house. An electric resistance heater with a 46,000 BTUH capacity serves as an auxiliary source.

DOMESTIC HOT WATER: Also included in the active system, a coil in the collector to storage duct preheats incoming water to be taken to the conventional domestic hot water heater.





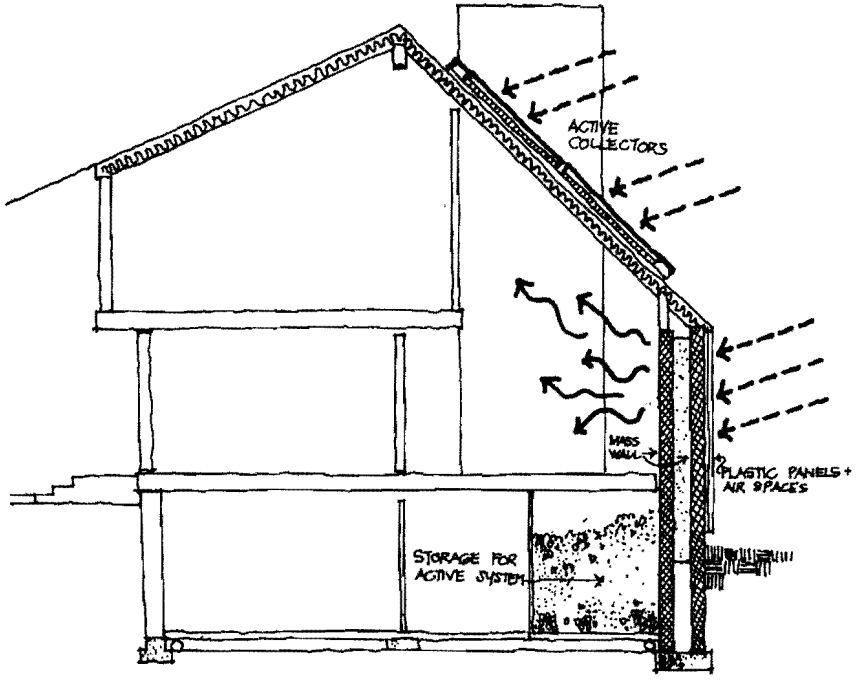
PROJECT INFORMATION:
BUILDER/APPLICANT: THS, Inc.
DESIGNER: Ron Kedzierski
SOLAR SUB: Polestar Consultants
LOCATION: Columbia, MD
HOUSING TYPE: SFD, 1 Unit
CLIMATIC DATA:
HEATING DD: 4,760
DESIGN TEMP: WINTER: 12° F
HORIZ. INSOL. JAN. DAY: 654 BTU/ft²

LATITUDE: 39°N
AREA: 3,134 sq. ft.

COOLING HRS: 850
SUMMER: 94° F
% SUN/YR: 50%

BUILDING DESCRIPTION/ENERGY CONCERNS

This project involves a single family detached home which uses a passive heating system (Trombe wall) in addition to an active heating system. To reduce heat loss, there are few north facing windows. To reduce heat gain, the windows on the southern exposure are recessed and fewer windows were placed to the west.



SOLAR ENERGY SYSTEM: HYBRID

SOLAR APPLICATION: Passive & Active Heating, Active DHW
PREDICTED SOLAR CONTRIBUTION: 68%

PASSIVE SYSTEM: The south wall of the house is constructed of massive concrete behind double glazing. The mass wall is thus heated by direct solar gain through the glazing. Radiation and natural convection transmit the collected heat from the wall to the living space, with a capacity of 13.5% of the total heating load.

ACTIVE SYSTEM: 486 sq. ft. of Sunworks flat plate collectors are located on the 45° slope of the south facing roof. Air blown through the collector transports heat to the 360 cu. ft. of rock storage located in the basement. The fan in the auxiliary system forces hot air from storage into the living space. An electric powered heat pump with a capacity of 30,000 BTUH is the auxiliary heat source.

DOMESTIC HOT WATER: In order to heat domestic hot water, incoming cold water is preheated in a coil, in the duct of the collector to storage circuit. Two conventional hot water tanks provide a boost for 100 gal. of DHW supply.

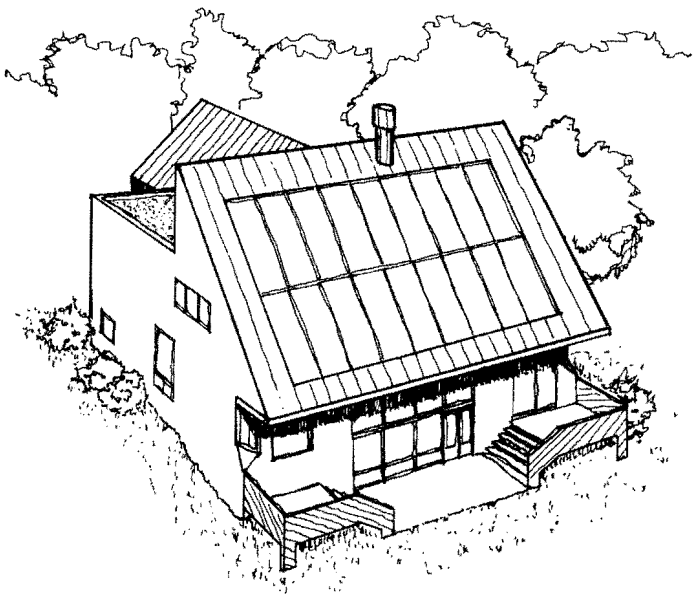
MODES OF OPERATION: In this system are: collector to storage, collector to house, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.

HYBRID HEATING & ACTIVE DHW SFD NEW 5101 DD PENNSYLVANIA

94

PROJECT INFORMATION:

BUILDER/APPLICANT: William Felton
DESIGNER: Jacobs & Kielman
SOLAR SUB: Solar Energetics
LOCATION: Penn Valley, PA
LATITUDE: 40°N
HOUSING TYPE: SFD, 1 Unit
AREA: 2,400 sq. ft.
CLIMATIC DATA:
HEATING DD: 5,101
COOLING HRS:
DESIGN TEMP: WINTER: 8° F
SUMMER: 95° F
HORIZ. INSOL. JAN. DAY: 570 BTU/ft²
% SUN/YR: 57%

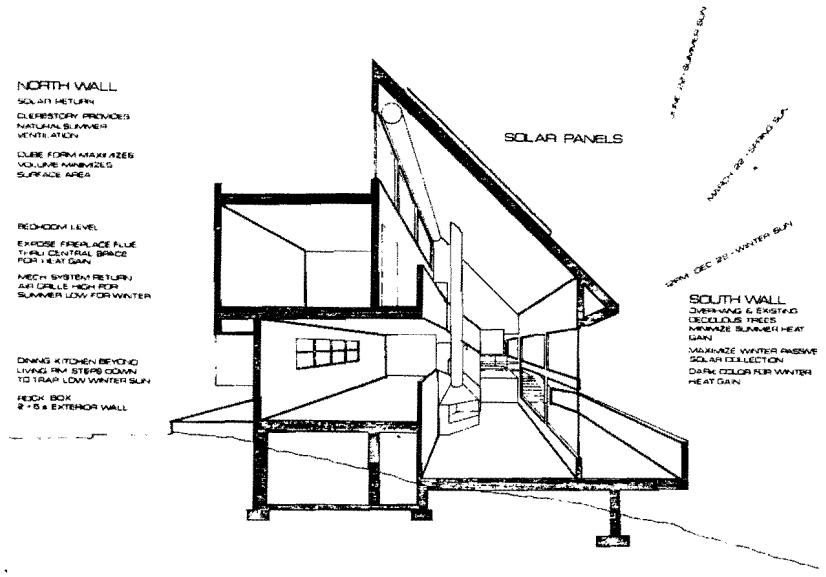


BUILDING DESCRIPTION/ENERGY CONCERNS

Because energy conserving features are so well thought out in this single family detached home, it is considered as an integrated active and passive, or hybrid solution. Designed as a cube to maximize the surface to volume ratio, openings are organized on the southern exposure. Garage placement was designed to additionally shield the northern exposure. Insulation has been increased throughout to 6 to 10" of batt. There is also double glazing and detailing against infiltration. The operable clerestory at the top of the large sloped roof allows natural cooling in summer, and provides continuous natural light to the living area.

SOLAR ENERGY SYSTEM: HYBRID

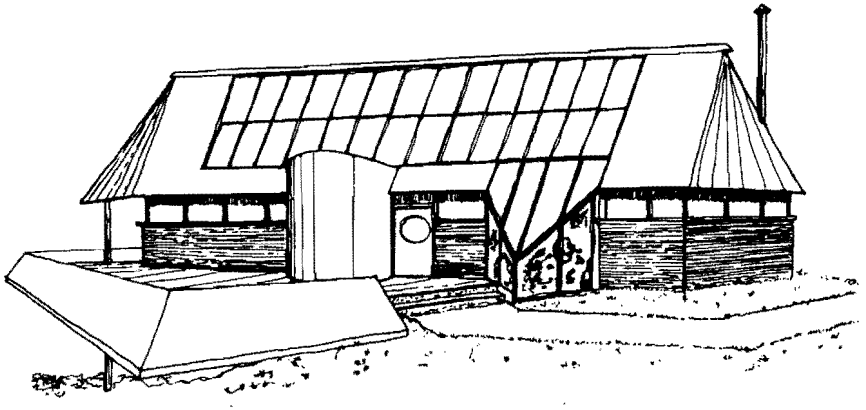
SOLAR APPLICATION: Passive & Active Heating, Active DHW
PREDICTED SOLAR CONTRIBUTION: 67%

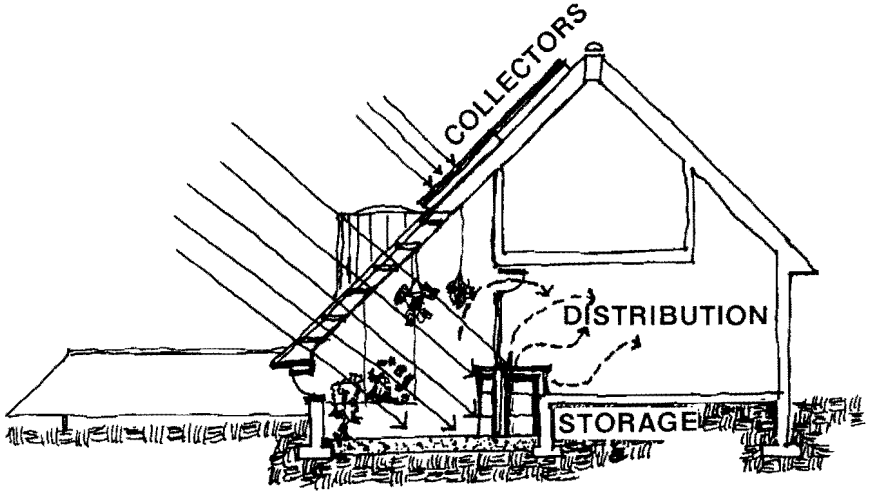


PASSIVE SYSTEM: A large 45° sloped roof along the entire southern face acts as the active collector location as well as a large thermal mass for passive solar collection and storage. The roof angle was determined by year round solar optimums, allowing the sun to heat the living space directly by convection and reradiation from this ceiling storage mass. In addition, a south glazed wall, shaded in summer, allows the low winter sun to penetrate deep into the house and be trapped by the upper floor sleeping areas. Insulated curtains are used to prevent heat loss at night. The use of high and low returns alternately distribute heat throughout the space or provide cooling ventilation.

ACTIVE SYSTEM: 585 sq. ft. of Solaron flat plate air collectors have been directly mounted to the roof at a 45° tilt facing 20° east of south. Once air is heated in the collectors, it is blown to 300 cu. ft. of rock storage. An air handling unit blows heated air from storage as needed. When heating demands cannot be met by the solar system and the central fireplace (predicted 25% yearly contribution), an oil fired furnace gives 95,000 BTUH of back-up energy.

DOMESTIC HOW WATER: The active system preheats the cold water supply in a coil located in the Solaron collector to storage circuit. Preheated water then goes to an 80 gal. conventional electric DHW heater.





BUILDER/APPLICANT: Spence-Urban & Associates
DESIGNER: Joint Venture, Inc., Architects
SOLAR SUB: Solaron Corp.
LOCATION: West Des Moines, IA
LATITUDE: 42°N
HOUSING TYPE: SFD, 2 Units
AREA: 2,418 sq. ft.
CLIMATIC DATA:
HEATING DD: 6,808
COOLING HRS:
DESIGN TEMP: WINTER: −7° F
SUMMER: 95° F
HORIZ. INSOL. JAN. DAY: 643 BTU/ft²
% SUN/YR: 62%

BUILDING DESCRIPTION/ENERGY CONCERNS

This project consists of 2 single family detached houses with 1,778.38 and 2,418.68 sq. ft. of floor area. The larger house, which contains both active and passive solar heating systems will be discussed here. Some of its many energy conserving features include: improved insulation, the elongation of the building mass on the E/W axis, giving maximum southern exposures; overhangs on the east, south and west faces to shade from the summer sun; and the location of garage and service areas on the north. Berms on the northern side also thermally insulate the living spaces. Windows and skylights are double glazed.

SOLAR ENERGY SYSTEM: HYBRID

SOLAR APPLICATION: Passive & Active Heating, & Active DHW
PREDICTED SOLAR CONTRIBUTION: 52%

PASSIVE SYSTEM: The air in the greenhouse is heated by direct solar gain when the insulating panels enclosing the glass space are opened on sunny days. The space then acts as a radiant heat source. Seven 50 gallon drums filled with water are located within the reach of the sun's rays at the rear of the greenhouse. These drums store solar heat to be distributed to the living space by natural convection and radiation. An internal fan in the active system's duct work circulates hot air from the ceiling of the greenhouse back to the floor area.

ACTIVE SYSTEM: 429 sq. ft. of flat plate air collectors are integrated into the roof structure at a 45° slope oriented south. Manufactured by Solaron, these collectors use air to transfer solar heat to 215 cu. ft. of crushed rock storage, located in the basement. From storage, heated air is blown to an air handling unit which delivers it to the living space. A heat pump and an electric resistance coil in the air duct provide 30,000 BTUH of backup energy for the heating system. Modes of operation are typical to the Solaron system.

DOMESTIC HOT WATER: An 80 gal. preheat tank holds heated water coming from a coil in the Solaron collector to storage circuit. Heated water is then transferred from the preheat tank to the conventional hot water heater.

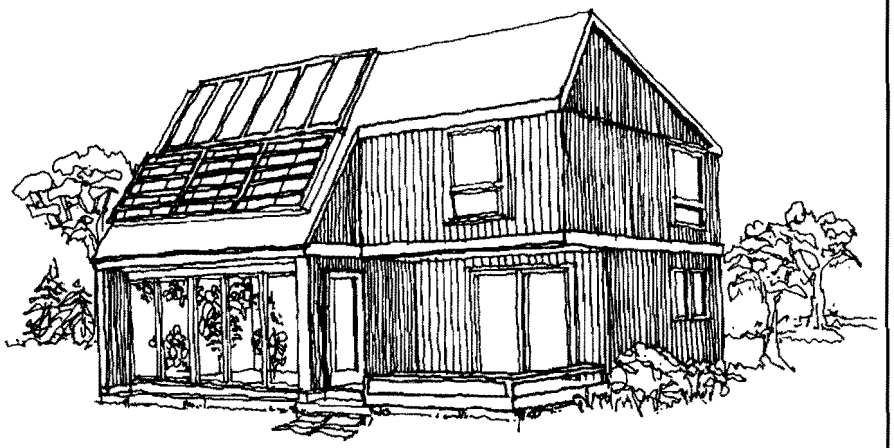
95 HYBRID HEATING & ACTIVE DHW 2 SFD NEW 6808 DD IOWA

HYBRID HEATING & ACTIVE DHW 1 SFD NEW 6894 DD MICHIGAN

96

PROJECT INFORMATION:

BUILDER/APPLICANT: *Lion Enterprises*
DESIGNER: *Donald Watson, Architect*
SOLAR SUB: Bel-Aire Heating & Air Conditioning
LOCATION: Almena Twp., MI
LATITUDE: 42°N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,468 sq. ft.
CLIMATIC DATA:
HEATING DD: 6,894
COOLING HRS:
DESIGN TEMP: WINTER: 5° F
SUMMER: 89° F
HORIZ. INSOL. JAN. DAY: 450 BTU/ft²
% SUN/YR: 49%



BUILDING DESCRIPTION/ENERGY CONCERNS

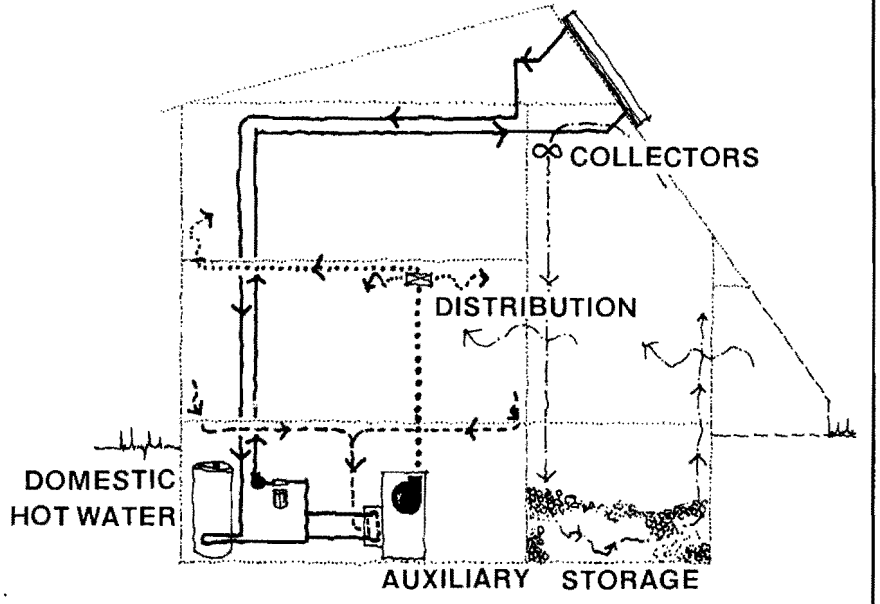
This prefabricated home uses a sunroom to provide passive space heating and an active system to provide hot water. It is one in a series of varying prefabricated solar homes (See Case 91). Service areas are located on the north side and living spaces on the south to assist in thermal optimization. The entry forms an airlock and all windows are of insulating glass. Minimum windows on the east and west faces inhibit winter heat loss and summer heat gain. North facing windows are high in order to vent the summer heat. First floor south facing windows are recessed, shading them from the summer sun.

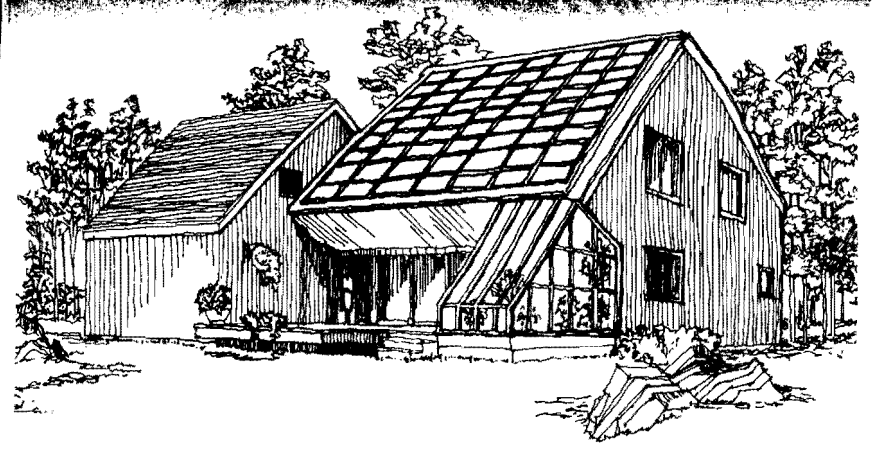
SOLAR ENERGY SYSTEM: HYBRID

SOLAR APPLICATION: Passive & Active Heating, Active DHW
PREDICTED SOLAR CONTRIBUTION: 44%

PASSIVE SYSTEM (see case 91): The air in the sunroom is heated by direct radiation gain through skylights and windows; the heated air is drawn from the upper part of the sunroom by a fan and blown to a rock storage under the house. The stored heat is transmitted through the floor as the living space becomes cooler. The sunroom can also be opened to the house for immediate heat gain. An exhaust fan prevents overheating in the summer. The auxiliary system consists of an oil furnace with a capacity of 85,000 BTUH, and a fireplace.

ACTIVE SYSTEM: 111 sq. ft. of Sunworks flat plate collectors are located on the 50° slope of the south facing roof. A propylene glycol/water solution transfers heat to a copper fin coil which is located in an 80 gal. hot water storage tank in the basement. This tank provides domestic hot water supply and carries its own auxiliary capability of 26,660 BTUH. A secondary copper fin coil is located in the standard furnace unit where it preheats return air to relieve the heating load.

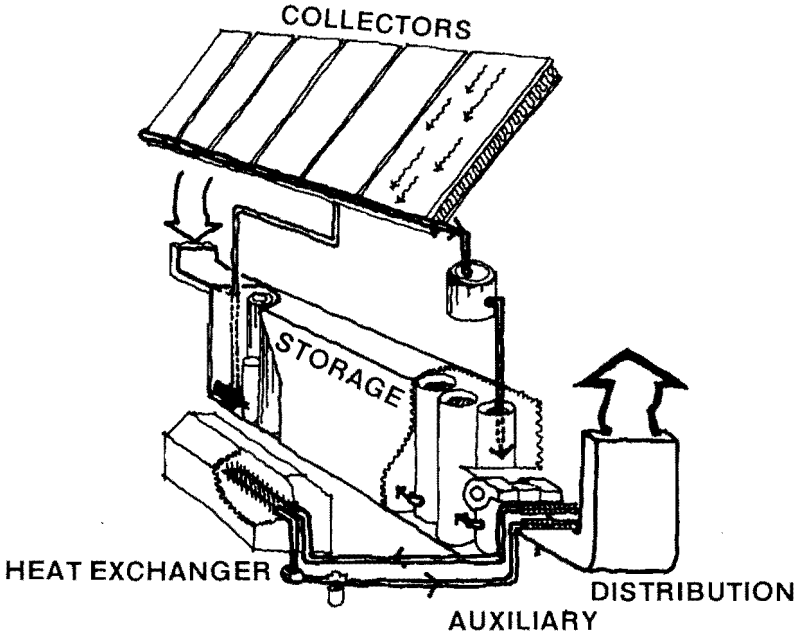




LOCATION: Hanisville, NH
HOUSING TYPE: SFD, 1 Unit
AREA: 1,400 sq. ft.
CLIMATIC DATA:
HEATING DD: 7,643
DESIGN TEMP: WINTER: −10° F
HORIZ. INSOL. JAN. DAY: 440 BTU/ft²
COOLING HRS:
SUMMER:
% SUN/YR: 52%

BUILDING DESCRIPTION/ENERGY CONCERNS

This project involves a 3-bedroom single family house of 1,400 sq. ft. In order to conserve energy insulation is increased beyond the standards, triple glazed windows are used throughout, and evergreens are planted on the northwest to reduce winter heat loss due to the wind. A greenhouse addition acts as a vestibule for the entry, providing an insulating airlock and a passive heat source.



SOLAR ENERGY SYSTEM: HYBRID

SOLAR APPLICATION: Passive & Active Heating, Active DHW
PREDICTED SOLAR CONTRIBUTION: 76%

PASSIVE SYSTEM: Direct heat gain through the south facing windows, and radiant heat provided by the greenhouse act as the passive heat source for this 3-bedroom home. In addition, fans draw hot air from high points in the house and redistribute it at low points into the living space.

ACTIVE SYSTEM: 460 sq. ft. of flat plate collectors are located on the south facing roof at a 60° slope. Custom built by the builder, the collectors use a corrugated panel in which water runs down the open channels to collect heat. The heated water is then carried to a series of connected cylindrical tanks within an insulated duct. Air is blown through this room size duct, directly transferring heat to the air distribution system of the house. A coil in the air supply duct transfers excess collected heat to a 210 gal. water storage tank, through a heat exchanger. When heating from storage, the preheated water is recirculated through the coil in the air supply duct. An electrical element in the storage tank provides auxiliary energy and allows off-peak hour usage of electrical power.

DOMESTIC HOT WATER: Cold water supply is taken through a coil submersed in the warmest of the cylinders, preheating water for domestic hot water supply.

HYBRID HEATING & ACTIVE DHW SFD NEW 7643 DD NEW HAMPSHI

97

HYBRID HEATING & ACTIVE DHW 1 SFD NEW 8382 DD WISCONSIN

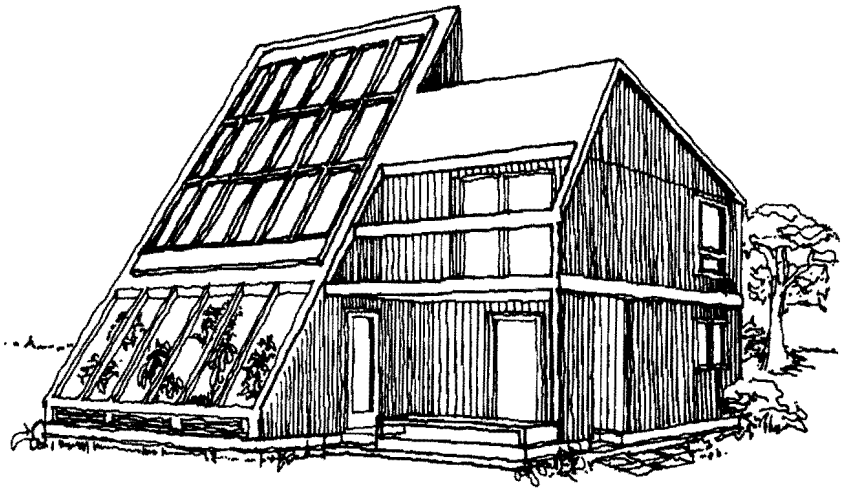
98

PROJECT INFORMATION:

BUILDER/APPLICANT: William Burdick
DESIGNER: Donald Watson, Architect
SOLAR SUB: Stan's Electric, Lake Heating, Lloyd King Plumbing
LOCATION: Rice Lake, WI **LATITUDE:** 46°N
HOUSING TYPE: SFD, 1 Unit **AREA:** 1,584 sq. ft.
CLIMATIC DATA:
HEATING DD: 8,382 COOLING HRS: 350
DESIGN TEMP: WINTER: −10° F SUMMER: 89° F
HORIZ. INSOL. JAN. DAY: 553 BTU/ft² % SUN/YR: 56%

BUILDING DESCRIPTION/ENERGY CONCERNS

This single family detached home encompasses 1,584 sq. ft. of living space and has 3 bedrooms. Its energy conserving features include placing the carport to the northwest, which serves to block the winter wind and shelter the entry. The kitchen, closets, bathrooms and service areas are also located on the north side to assist in insulating the living space against heat loss. The sunroom and the living area are oriented to the south to maximize use of winter sunshine. Triple glazing and good insulation is used throughout the house, with air locks and weather-stripping added to stop infiltration. Windows are placed high on the north face to allow heat to escape in the summer, while south facing windows have shading devices (See Case 91).



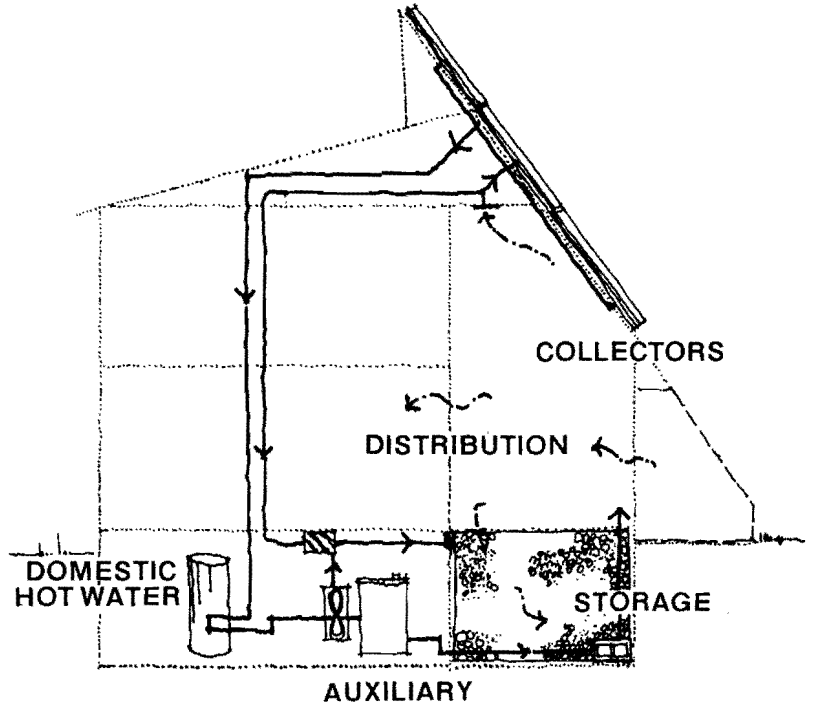
SOLAR ENERGY SYSTEM: HYBRID

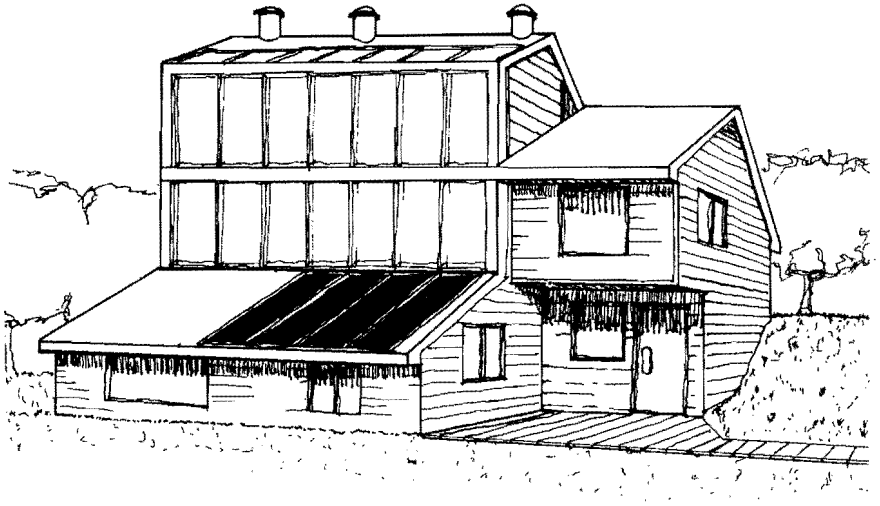
SOLAR APPLICATION: Active & Passive Heating, Active DHW
PREDICTED SOLAR CONTRIBUTION: 51%

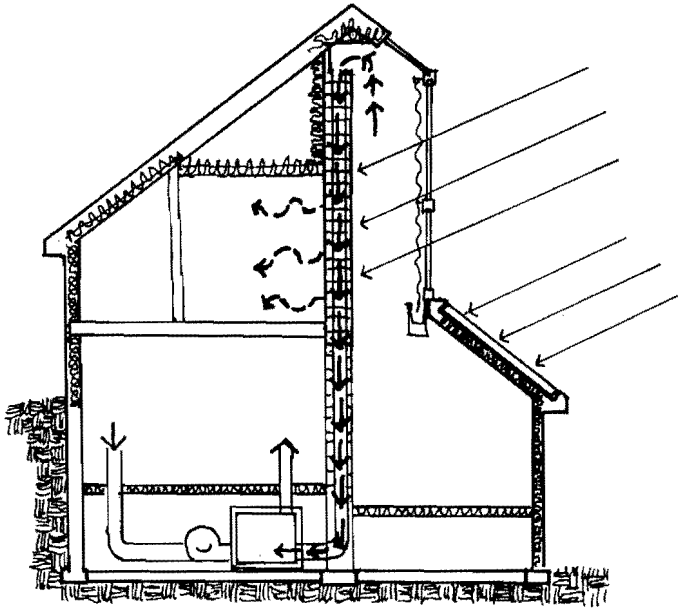
PASSIVE SYSTEM: The sun directly heats the air in the sunroom through south facing windows. When direct heating is desired, the sunroom is opened to the rest of the house. The heated air which has risen to the top of the room is blown into the rock storage of the active system. Cooler air is returned at the base of the glazing in the sunroom and the circulation continues.

ACTIVE SYSTEM: 335 sq. ft. of flat plate air collectors are integrated with the roof structure of the house, facing south at a 54° tilt. The collectors are manufactured by Solaron. Solar heated air is taken directly to the house or to a rock storage bin in the basement, via an air handler. An electric furnace, in series with the air handler, acts as the auxiliary heat source. Its capacity is 66,000 BTUH. The modes of operation of this system are: collector to house (via air handler), collector to storage, storage to house, storage to auxiliary to house, auxiliary to house, DHW preheat.

DOMESTIC HOT WATER: Cold water supply is pumped through a finned water coil located in the collector loop, transferring solar heat to an 80 gal. preheat tank, which circulates hot water to a conventional DHW heater.







PROJECT INFORMATION:

BUILDER/APPLICANT: Greenmoss Builders, Co.
DESIGNER: Circus Studios
SOLAR SUB: North Wind Power Co., Inc.
LOCATION: Waitsfield, VT
LATITUDE: 44°N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,244 sq. ft.
CLIMATIC DATA:
HEATING DD: 7,876
COOLING HRS:
DESIGN TEMP: WINTER: 4° F
SUMMER:
HORIZ. INSOL. JAN. DAY: 410 BTU/ft²
% SUN/YR: 46%

BUILDING DESCRIPTION/ENERGY CONCERNS

This single family home is 1,244 sq. ft. in area and has 2 bedrooms. In order to conserve energy, the windows are double glazed and there are no windows on the north wall. The entry room forms an airlock, and is shielded from the wind by the building mass. The building envelope is reduced to a minimum. The north roof is steeply sloped to deflect the wind, with an earth berm built up on the north for further resistance. The site on the south side is graded parabolically so that reflectance onto the collector will be increased.

SOLAR ENERGY SYSTEM: HYBRID

SOLAR APPLICATION: Passive & Active Heating, Active DHW
PREDICTED SOLAR CONTRIBUTION: 54%

PASSIVE SYSTEM: Radiation strikes a large block storage wall after passing through the south facing windows, to create a passive heat supply. Air is forced through cavities in the block to collect heat, and it is distributed through the furnace in the basement, to supply the house. An insulating curtain can be pulled across the glass to prevent heat loss on cloudy days or at night. Fireplaces provide additional heat for the house, with the flues placed inside the block wall for maximum use of fireplace heat. A gas fired furnace serves as backup with a capability of 75,000 BTUH.

ACTIVE SYSTEM: The conventional gas-fired heating system uses an active component, a fan, to force passively heated air through cavities in the thermal block wall.

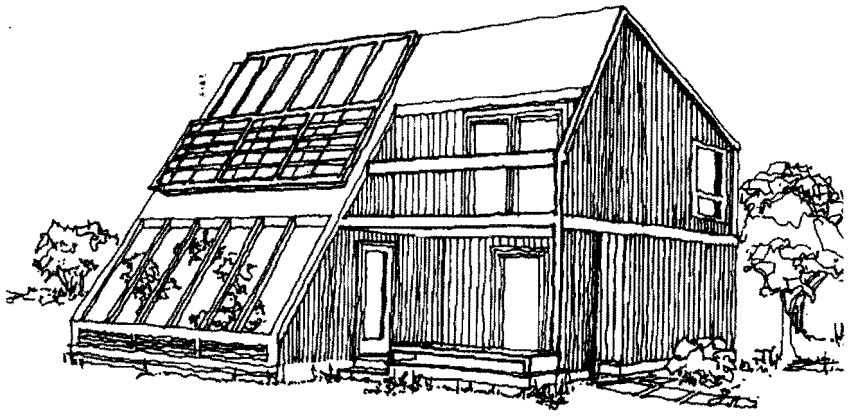
DOMESTIC HOT WATER: Sun Earth flat plate collectors cover 76 sq. ft. of the 47° sloped south roof. Water is used as the transfer medium. Freezing can be prevented by pumping warmer water from storage through the collector. Solar heated water is returned to the 80 gal. water storage tank located in the basement. From here domestic hot water is distributed conventionally. A gas fired standard water heater is used as an auxiliary.

HYBRID HEATING & ACTIVE DHW SFD NEW 10,000 DD MINNESOTA

100

PROJECT INFORMATION:

BUILDER/APPLICANT: Red Barn Realty Co.
DESIGNER: Donald Watson, Architect
SOLAR SUB:
LOCATION: Esko, MN
LATITUDE: 47°N
HOUSING TYPE: SFD, 1 Unit
AREA: 1,589 sq. ft.
CLIMATIC DATA:
HEATING DD: 10,000
COOLING HRS: 350
DESIGN TEMP: WINTER: −15° F
SUMMER: 82° F
HORIZ. INSOL. JAN. DAY: 553 BTU/ft²
% SUN YR: 55%



BUILDING DESCRIPTION/PASSIVE DESIGN CONCERNS

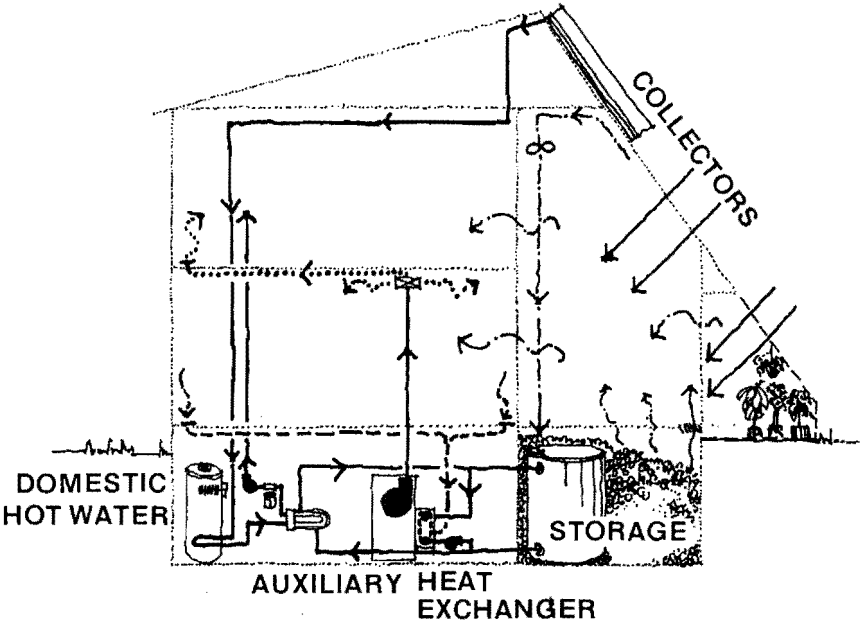
This prefabricated house encompasses 1,305 sq. ft. of floor area with an additional 284 sq. ft. of sunroom. In order to conserve energy all service spaces—kitchens, closets and bathrooms—are located on the north side to insulate the living space from northern winds. The decks, sunroom and living space are oriented to the south to make use of winter heat gain. Good insulation is used throughout the house with air locks and weather stripping employed to stop infiltration. Triple glazing is used on all windows. Windows on the north wall are placed high to allow heat to escape in the summer. Southern windows have shading devices.

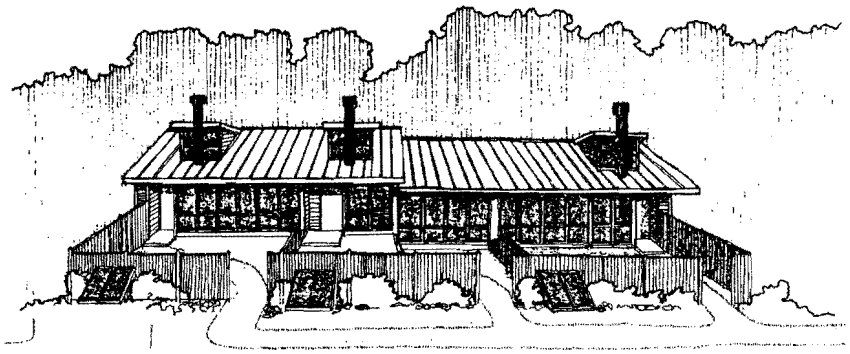
SOLAR ENERGY SYSTEM: HYBRID

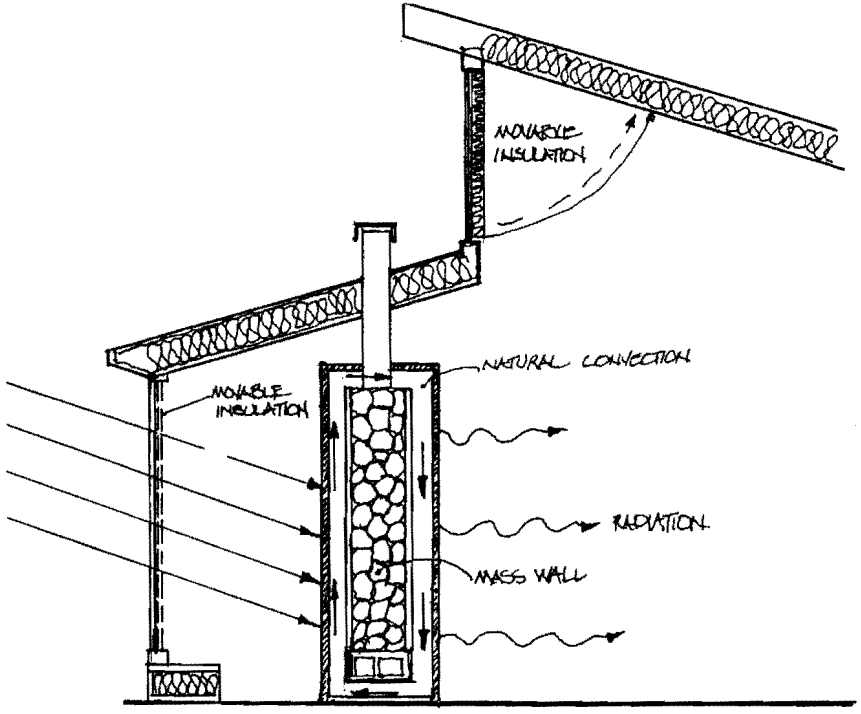
SOLAR APPLICATION: Active & Passive Heating, Active DHW
PREDICTED SOLAR CONTRIBUTION: 32%

PASSIVE SYSTEM: Direct solar gain coming through windows in the sunroom heats the air in the room. A fan in the ceiling of this space draws heat out and blows it into rock storage which is located in the basement of the house. The rock storage then becomes a heat source. When the air in the rock storage cools, it is returned at the bottom of the sunroom windows, initiating a new heating cycle. A backdraft damper prevents the cool air from returning to storage.

ACTIVE SYSTEM: 205 sq. ft. of flat plate liquid collectors are directly mounted to the roof, facing 5° west of south at a 50° tilt. Manufactured by Sunworks, these collectors use a liquid solution of propylene glycol to transfer heat, via a heat exchanger, to water storage. A 1,000 gal. water tank is located in the passive systems' rock storage bin in the basement of the house. From here, water is pumped through a coil over which air is blown into the living space in a conventional forced hot air distribution system. An oil furnace provides 85,000 BTUH of backup energy. Modes of operation for this system include: collector to house (via heat exchanger), collector to storage (via heat exchanger), storage to house, auxiliary to house, DHW preheat. In order to heat domestic hot water, a second heat exchanger is placed in the 65 gal. DHW tank. It provides heat from the collector loop. An electric resistance coil in the tank supplies backup heat.







PROJECT INFORMATION:

BUILDER/APPLICANT: Beatrice Mongeau
DESIGNER: Designworks
SOLAR SUB: Sunspot Solar Products, Inc.
LOCATION: Pittsboro, NC
LATITUDE: 36°05'N
HOUSING TYPE: SFA, 3 Units
AREA: 840 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 3,450
COOLING HRS: 1,050
DESIGN TEMP: WINTER: 15° F
SUMMER: 95° F
HORIZ. INSOL. JAN. DAY: 850 BTU/ft²
% SUN/YR: 61%

BUILDING DESCRIPTION/ENERGY CONCERNS

This project contains 3 units of single family attached houses with 840 sq. ft. per one bedroom unit. It has been retrofitted from a concrete block storage structure. In order to conserve energy, existing dividing walls and windowless end walls which are oriented east and west have been used to separate units and not punctured with openings. This eliminates east/west morning and afternoon summer heat gains. The plan is organized with service spaces and minimum openings on the north wall which increases thermal insulation. Living spaces are open to the south. 6" batt insulation in the walls and 10" batt insulation in the roof, has been added. All glazing is insulating glass. Overhangs on the south wall prevent summer heat gain, while insulating shutters deter winter heat loss.

SOLAR ENERGY SYSTEM: HYBRID

SOLAR APPLICATION: Passive & Active Heating, Active DHW
PREDICTED SOLAR CONTRIBUTION: 92%

PASSIVE SYSTEM: 140 sq. ft. of south facing window allows direct heat gain to a block and rock thermal mass wall. The wall also containing a fireplace becomes the building's heat source. Heat is distributed by natural convection and radiation. Insulating shutters are closed at night to contain the wall's heat.

ACTIVE SYSTEM: Domestic Hot Water: 36 sq. ft. of flat plate liquid collector is rack mounted on the ground at 45° facing due south. Manufactured by Revere, these collectors use water to transfer heat to storage. The drain down method is used to prevent freezing. 30 gal. of water storage, in a glass lined preheat tank, are located at the top of the mass storage wall. Preheated water is then circulated to a 30 gal. conventional electric DHW tank which is capable of supplying its own auxiliary heat. An additional water loop from the preheat tank goes into the thermal mass wall to provide an active auxiliary heat source. There are also individual electric baseboard heaters in each space to act as a backup system.

HYBRID HEATING & ACTIVE DHW 2 SFA RETRO 6283 DD COLORADO

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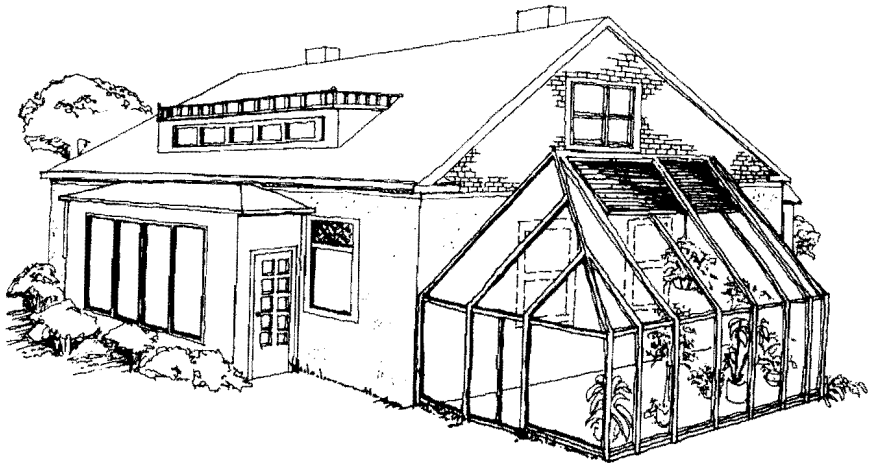
PROJECT INFORMATION:

BUILDER/APPLICANT: Robert Naumann
DESIGNER: Robert Naumann, P.E.
SOLAR SUB: Solar Hydronics Corp.
LOCATION: Boulder, CO
LATITUDE: 40°N
HOUSING TYPE: SFA, 2 Units
AREA: 850 sq. ft./unit
CLIMATIC DATA:
HEATING DD: 6,283
COOLING HRS:
DESIGN TEMP: WINTER: −10° F
SUMMER: 75° F
HORIZ. INSOL. JAN. DAY: 900 BTU/ft²
% SUN/YR: 70%



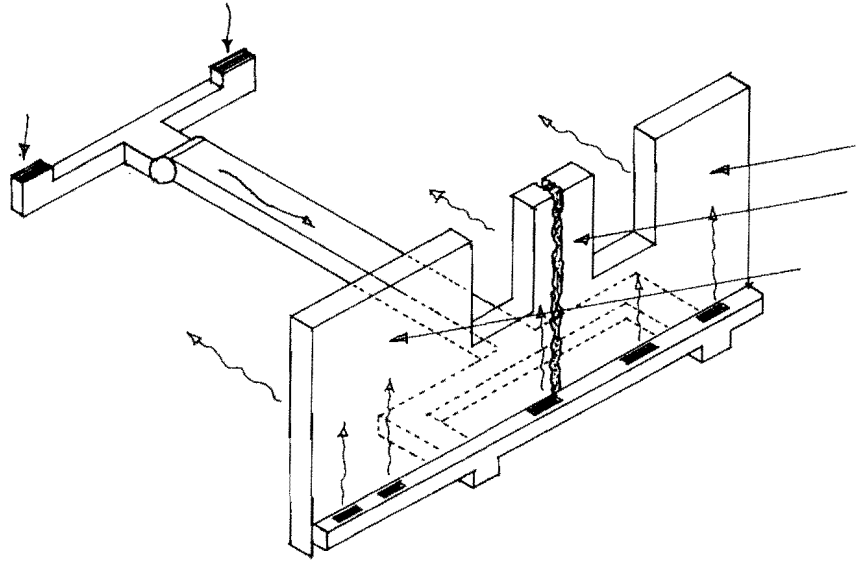
BUILDING DESCRIPTION/ENERGY CONCERNS

This duplex encompasses 850 sq. ft. per two bedroom unit and can also serve as a single family house. The building has been retrofitted with an active solar DHW system and a hybrid solar heating system. Energy conserving features include: applying a stucco veneer to the entire house to better insulate the concrete block walls; using storm windows throughout; berming on the southwest to deter convective losses; and, adding a greenhouse to thermally insulate the living space.

SOLAR ENERGY SYSTEM: HYBRID

SOLAR APPLICATION: Passive & Active Heating, Active DHW
PREDICTED SOLAR CONTRIBUTION: 65%

PASSIVE SYSTEM: By enclosing an existing porch with glass, a solarium was created on the south side of the building. The plants, the red absorbent floor paving and the built-up back wall act as a heat sink to radiate passive heat to the living space. A slightly forced convection also distributes heat to the living space, when the house return air is ducted across the basement and blown up with a low-volume fan through the thermal mass wall. Beadwall construction is used to insulate the solarium against summer heat gain and nighttime winter heat loss. In a bead wall, styrofoam beads are blown into a glass fiber sandwich panel for insulation, or vacuumed out to a bead storage bin when unnecessary.
ACTIVE SYSTEM: An active component in the solar heating system, a low-volume fan, blows return air back through the thermal mass wall, initiating the convective cycle for active and passive space heating.
DOMESTIC HOT WATER: 48 sq. ft. of liquid tubular concentrating collectors are integrally mounted on the roof of the solarium at a 40° tilt facing south. Heat is transferred by water to a 50 gal. water tank, via a heat exchanger in the tank. The drain down method is used to prevent freezing. Collectors are manufactured by KTA Corporation. The common storage tank is located in the basement, and acts as a preheat for a shared conventional 58 gal. DHW tank. Heated water from the preheat tank is passed through a copper spiral coil in the conventional DHW heater, which also provides the auxiliary heat source. The heated water is then distributed through a conventional domestic hot water system.



appendix

definition of terms

Liquid System

Air System

Active Solar Systems can be characterized as one in which an energy

by allowing stored heat, whether inadequate or not, to pass through

*__Storage to Auxiliary to House__—an energy boost could also be provided

PROJECT INFORMATION

SFD Single family detached.

SFA Single family attached; duplex or townhouse units, each with private entrances.

MFLow Multi-family low-rise; garden apartment buildings with common entrance.

MFMid Multi-family mid-rise; apartment buildings of 4-6 stories with elevator service.

MFHigh Multi-family high-rise; apartment buildings of 7 or more stories and above with elevator service.

Heating Degree Days (DD) are the number of degrees that the average daily temperature is below 65°. Normally heating is not required in a building when outdoor daily temperature is 65°. Heating degree days are determined by subtracting the average daily temperature below 65°, from the base of 65°. A day with an average temperature of 50° has 15 degree days (65 − 50 = 15), while one with an average temperature of 65° or above has none. A map of heating degree days throughout the United States follows.

Cooling Hours: The difference between the median temperature for an hour and the summer design temperature of 85°, is multiplied by the number of hours in each Dry Bulb temperature range and summed for the total number of cooling hours for the summer months. A map of yearly cooling hours throughout the United States follows.

Horizontal Insolation: In general, solar radiation is measured on a horizontal surface and is the sum of both direct and diffuse sky radiation. January Day Horizontal Insolation is a measure of the mean monthly average of radiation incident to a horizontal surface for a specific region. It can be given in BTU/day or Langley/day where 1 BTU = 3.7 Langleys. A map of mean daily radiation in the months of January and June is included for comparison.

BUILDING DESCRIPTION/ENERGY CONCERNS

Energy conserving buildings do not rely solely on the conversion of solar radiation into thermal energy for the provision of occupant comfort. Energy conservation in building design also implies the reduction of the heating and cooling demand of a house—via better thermal design principles. The two, functioning together, fulfill the ideals expressed in the words "integrated solar architecture." By reducing the demand, one can increase the efficiency of the alternative (solar) supply and approach self-sufficiency in present day heating and cooling of buildings. In the building description of the preceding projects, design features which influence energy-use efficiency are credited. These include building orientation, location and massing, the use of berming, vegetation, improved building envelope design (through improved section design, insulation) careful window and door placement, and the use of additives: awnings, movable insulation, curtains, vents . . .

SFA Single family attached; duplex or townhouse units, each
SFD Single family detached.

SOLAR ENERGY SYSTEMS

Active Solar Systems can be characterized as one in which an energy resource, in addition to solar, is used for the transfer of thermal energy. This additional energy, generated on or off the site, is required for pumps, blowers, or other heat transfer medium moving devices necessary for system operation. Generally, the collection, storage, and distribution of thermal energy is achieved by moving a transfer medium throughout the system with the assistance of pumping power.

Collector: The collector subsystem is the assembly used for absorbing solar radiation, converting it into useful thermal energy, and transferring the thermal energy to a heat transfer fluid. Collectors vary in configuration to include flat plate, concentrating, and tracking collectors. They can be mounted directly to a finished roof, integrated with the roof structure, or mounted to racks on the roof or at a location separate from the building.

Heat Transfer Media: The heat transfer media is a fluid used in the transport of thermal energy. In some systems the transport media is air, while in others, a liquid such as water or a water/antifreeze solution is used.

Closed or Open Loop Circuits: In an open loop, one medium serves as the collector and storage, or storage and distribution heat transfer medium. In a closed loop, a primary transport medium transfers heat through a heat exchanger to a second medium which retains or carries the collected heat. Systems using anti-freeze usually use a closed loop to isolate the collector solution from solar storage, which may need to remain potable.

Storage: The component of the solar energy system which stores the collected solar heat. It may be a rock bed, a water tank, a solid mass wall . . .

Auxiliary Energy Systems: These systems consist of equipment using conventional energy sources both to supplement the output provided by the solar energy system as required by the design conditions, and to provide full energy back-up requirements when the solar heating or DHW systems are inoperable.

Modes of Operation: Each active solar heating system has the potential to transfer heat in several circuits:

*__Collector to House__—solar heat is transported directly from the collector to the building, bypassing storage.

*__Collector to Storage__—heat is transported from the collector to a storage unit for immediate or later distribution.

*__Storage to House__—a mode in which stored heat can be transported to the point of distribution in response to house demand.

*__Auxiliary to House__—when the solar system is inadequate or non-functioning, separate energy systems will provide enough back-up energy to handle the total load.

*__Storage to Auxiliary to House__—an energy boost could also be provided by allowing stored heat, whether inadequate or not, to pass through the auxiliary energy system before distribution.

*__Auxiliary toStorage to House__—if solar storage serves also as the distribution media, the auxiliary energy system will heat solar storage whenever collected energy is inadequate to meet distribution temperature requirements. This also allows for loading and storing of electric energy in the cheaper off-peak hours, for later use.

*A secondary transport media may be introduced at any time through a heat exchanger or an air handling unit.

Passive Solar Systems can be characterized as those in which solar energy alone is used for the transfer of thermal energy. This system requires no pumps, blowers, or other heat transfer medium moving devices which use energy other than solar. The major component in a passive solar system generally utilizes a mass with high thermal capacitance, where heat is collected, stored, and distributed to the building without additional pumping power. Collection, storage and distribution are achieved by natural heat transfer phenomena employing convection, radiation and conduction in conjunction with the use of thermal capacitance as a heat flow control mechanism.

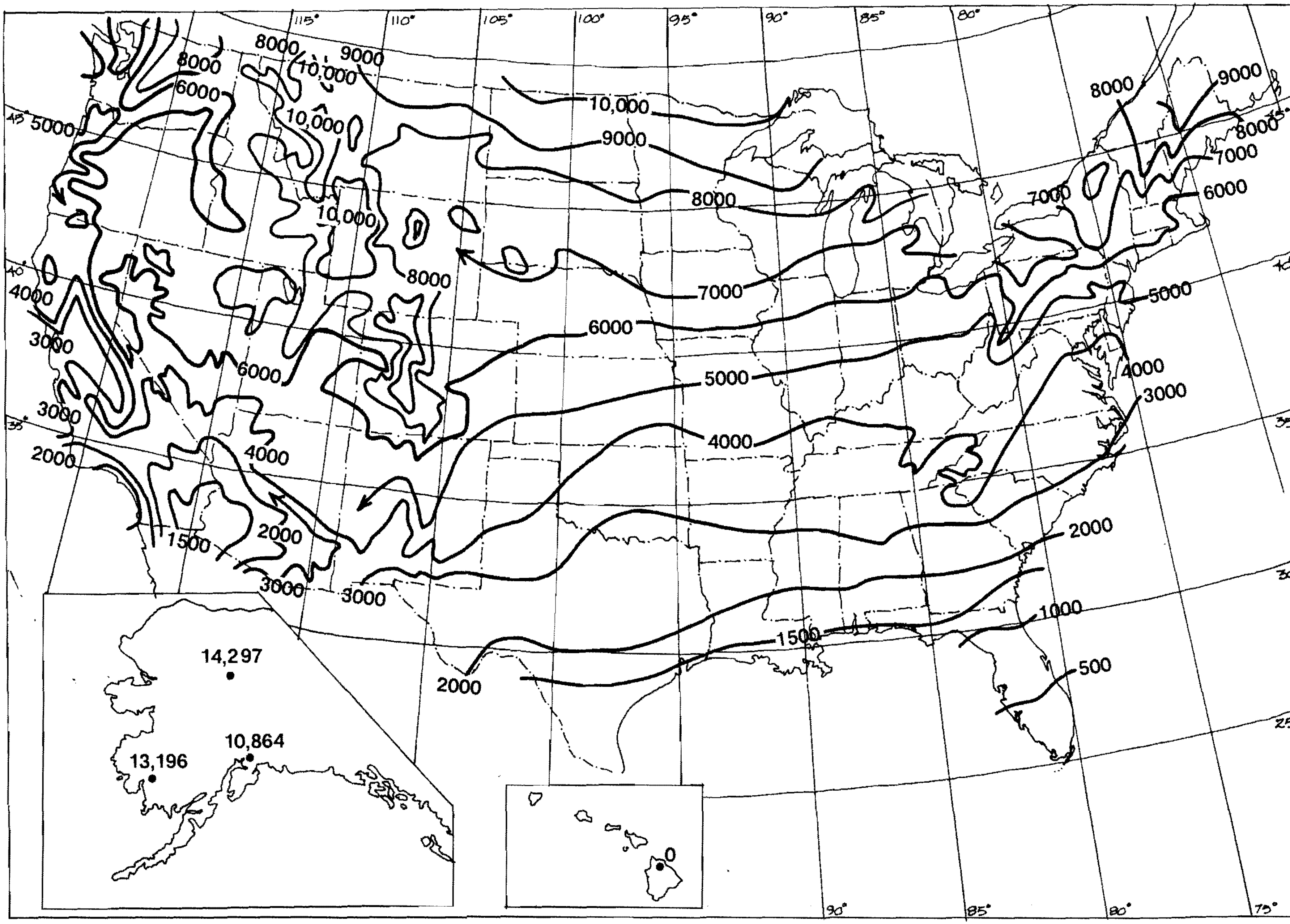
Hybrid Solar Systems refer to all projects where both passive and active solar systems combine to provide solar space heating. A strictly passive solar heating system in addition to a separate active domestic hot water system is still categorized as a passive system example.

Domestic Hot Water Systems (DHW) Although simply designated as one mode in the active system modes of operation, DHW preheat is accomplished by several methods.
1) city water can travel through a coil in storage or in the collector-storage loop to preheat water before placement in a preheat and/or conventional hot water tank. 2) city water can also fill a preheat tank located in solar storage to maintain preheated water for demand or for transfer to a conventional tank. 3) heated storage media can travel through a loop in the DHW tank to preheat water.

For active domestic hot water systems only, two other methods are often seen 1) city water is transported directly through the collector to a conventional hot water tank or to the house fixtures, and 2) city water goes to the solar storage tank, displacing preheated water provided by a second solar loop.

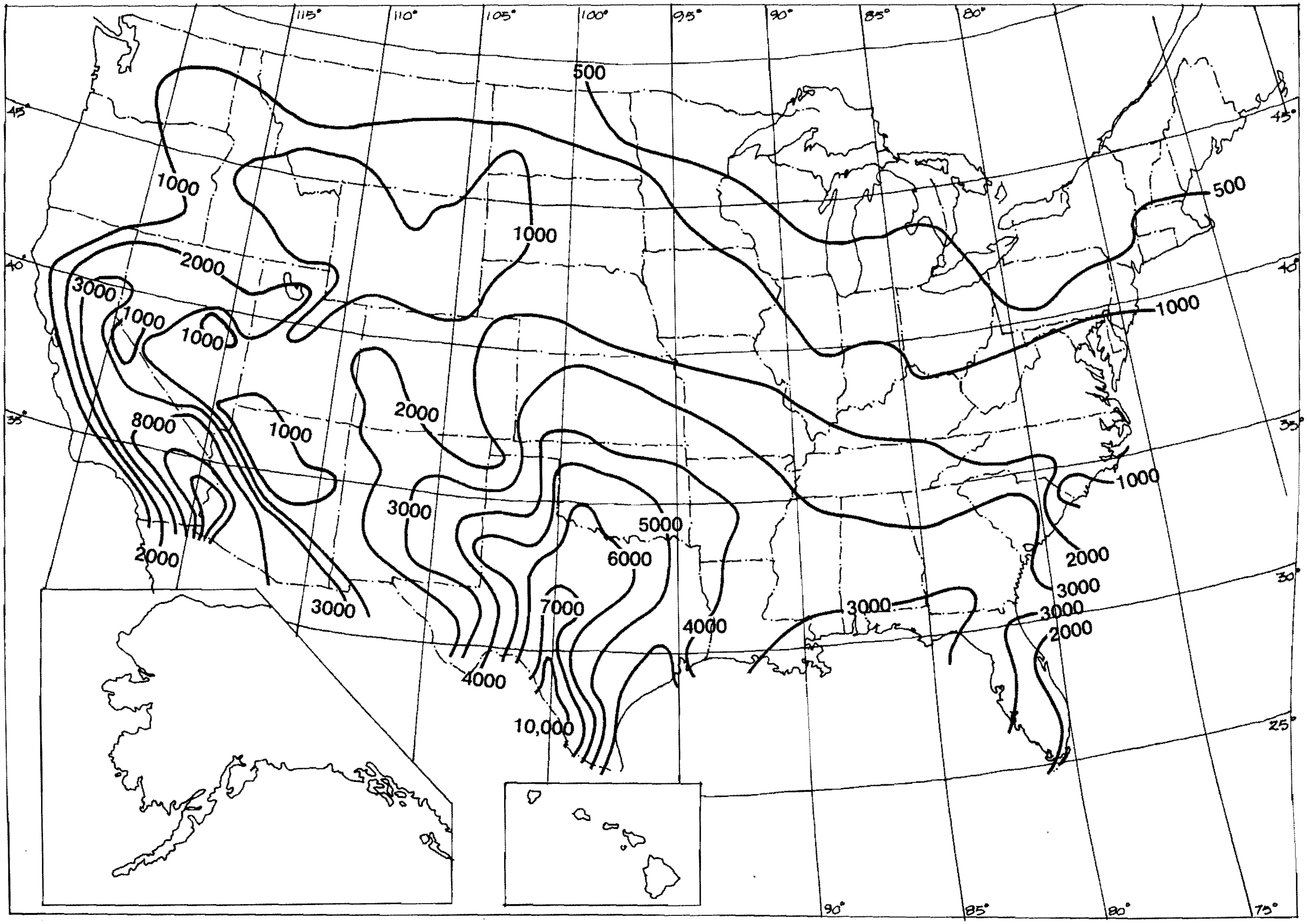
Thermosyphoning: In a passive domestic hot water system, city or cold water supply is pressure fed to a storage tank located above the solar collectors. Exposure of the collectors to solar radiation causes the cold water to circulate by convection from bottom to top of the collectors, and once heated back to the storage tank. The heated water is then stored until demand is initiated and then gravity fed to the dwelling.

annual heating degrees days (base 65° f)

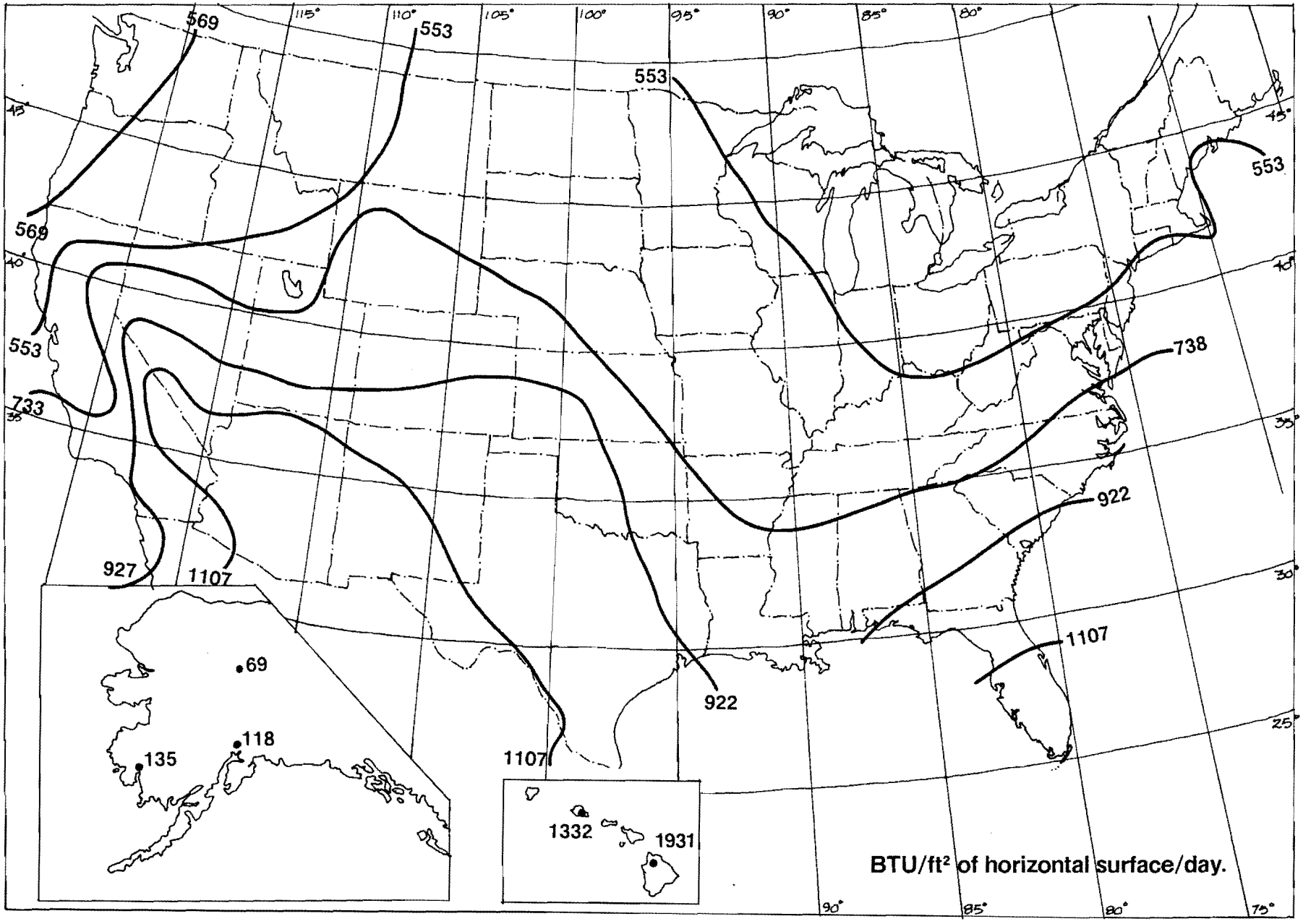


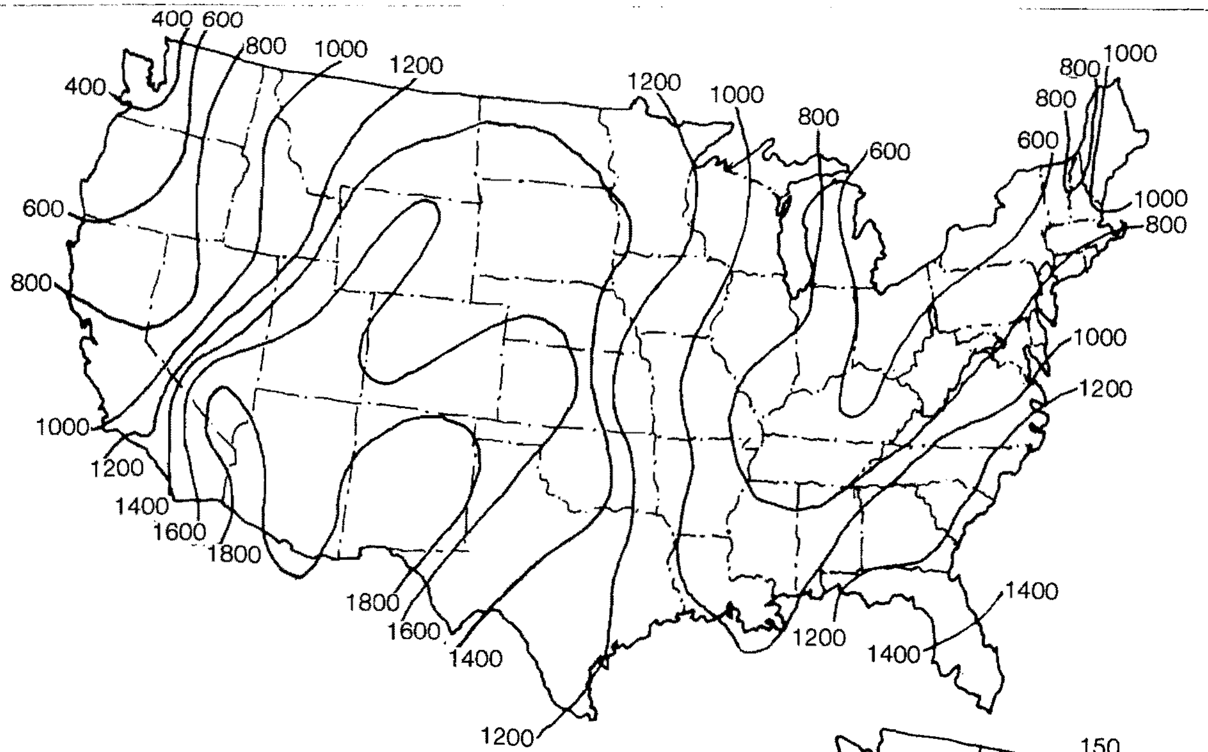
annual heating degrees days (base 65° f)

annual cooling degree hours (base 85° f)



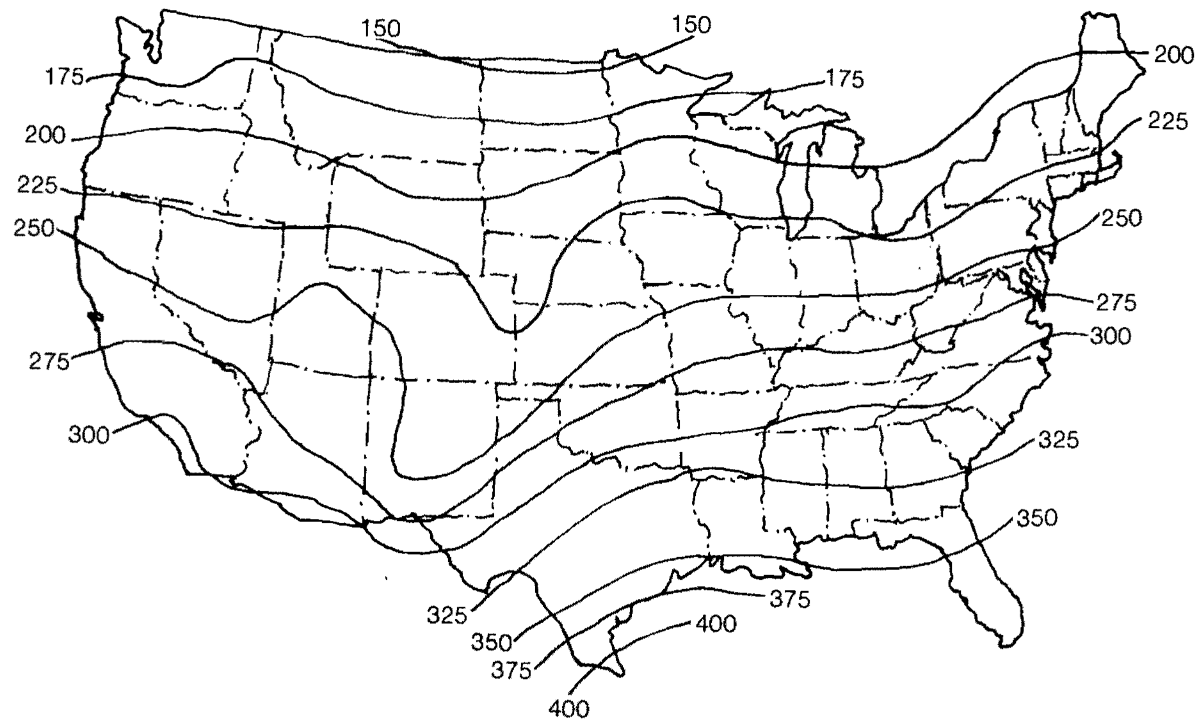
daily mean radiation, january





JANUARY
DIRECT RADIATION
on tilted surface
Latitude + 20°
(BTU/ft²/day)

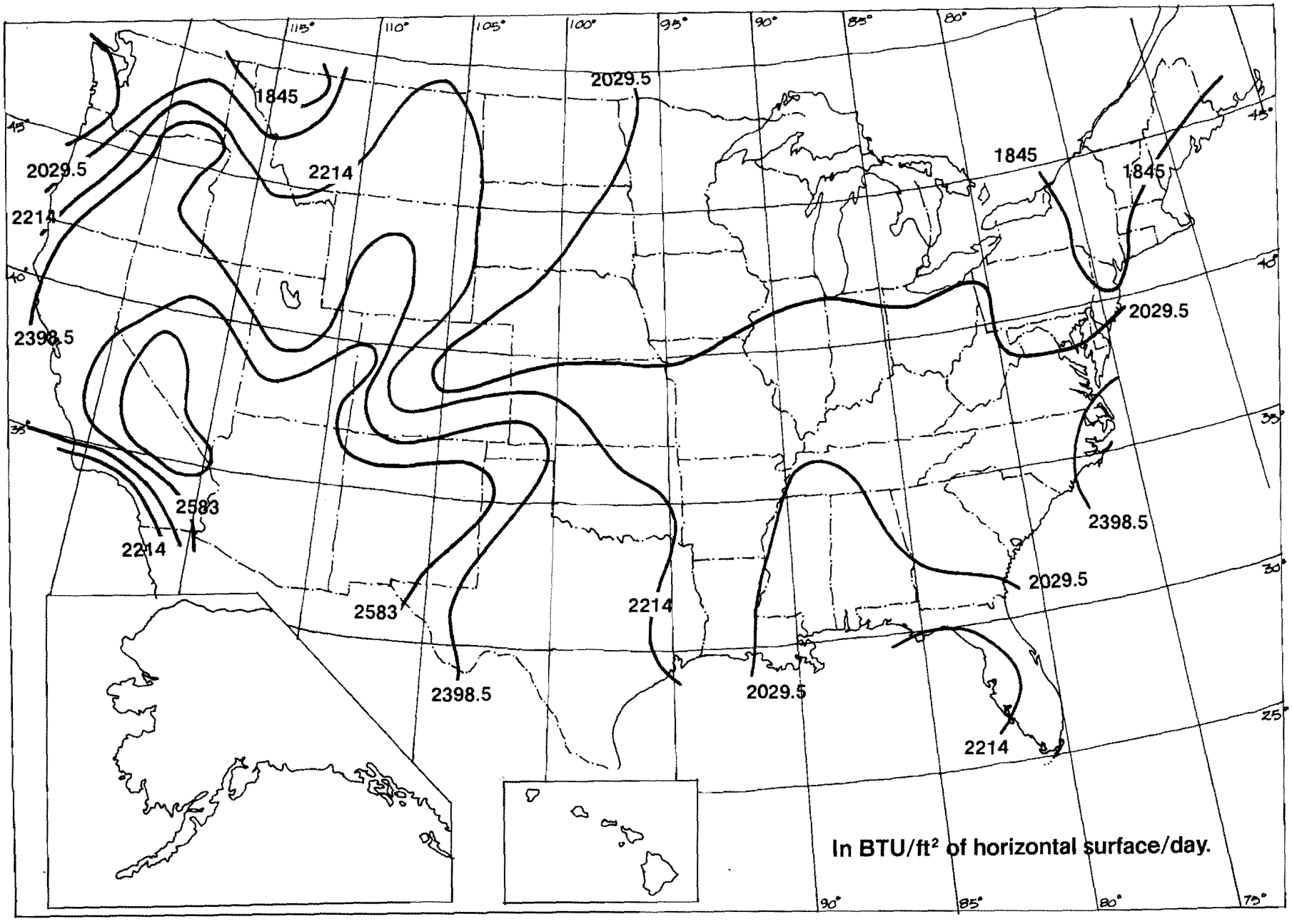
JANUARY
DIFFUSE RADIATION
on horizontal surface
(BTU/ft²/day)

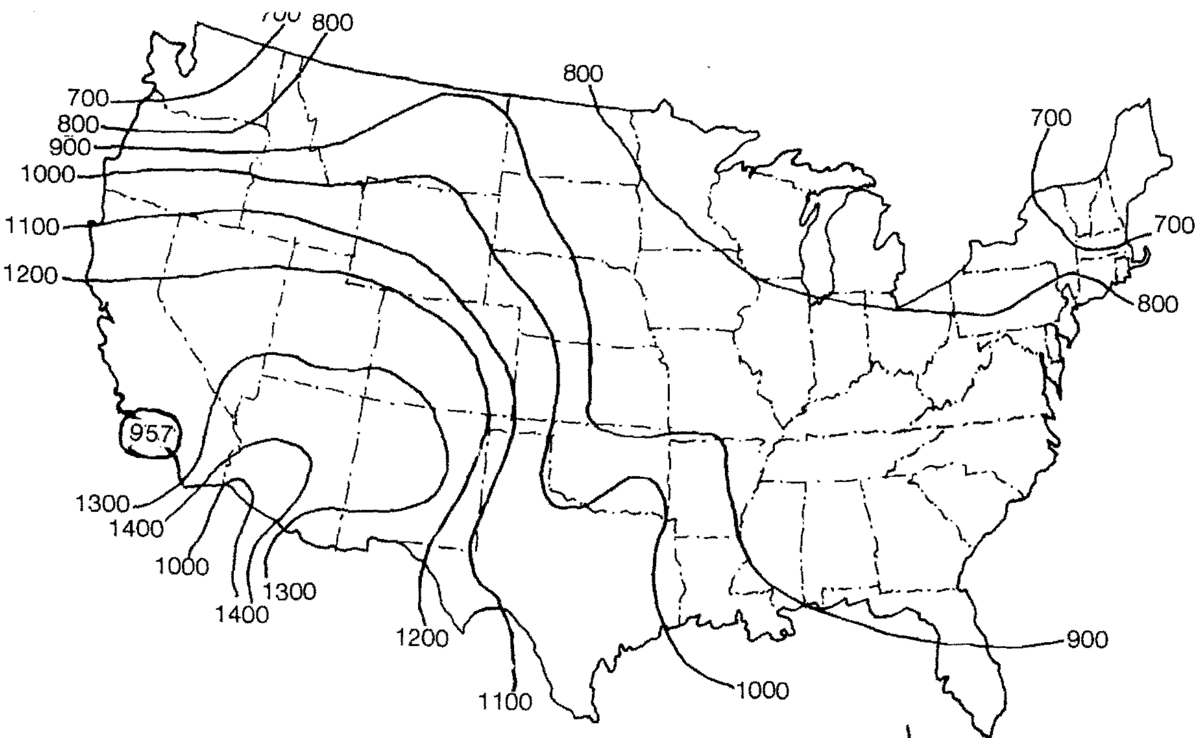


MEAN DAILY RADIATION ($BTU/FT^2/DAY$) FOR A SURFACE TILTED LATITUDE +20° = DIRECT RADIATION$_{TILT}$ + DIFFUSE RADIATION$_{HORIZ. \cong TILT}$

The mean radiation or insolation values just given for a horizontal surface, do not indicate the actual radiation obtainable on a tilted collector surface. During the month of January, the low sun angle defines a collector tilt of latitude +20° for optimal gain of direct radiation. To determine the *increased* radiation gain over the horizontal measurement, add the direct radiation received by a surface tilted to latitude +20° (at your location) to diffuse radiation on a horizontal surface (which approximates that at a tilt). Collector surfaces tilted to an angle less than latitude +15° or 20° will receive less direct radiation during the winter heating months, approaching the previous values of mean radiation on a horizontal surface.

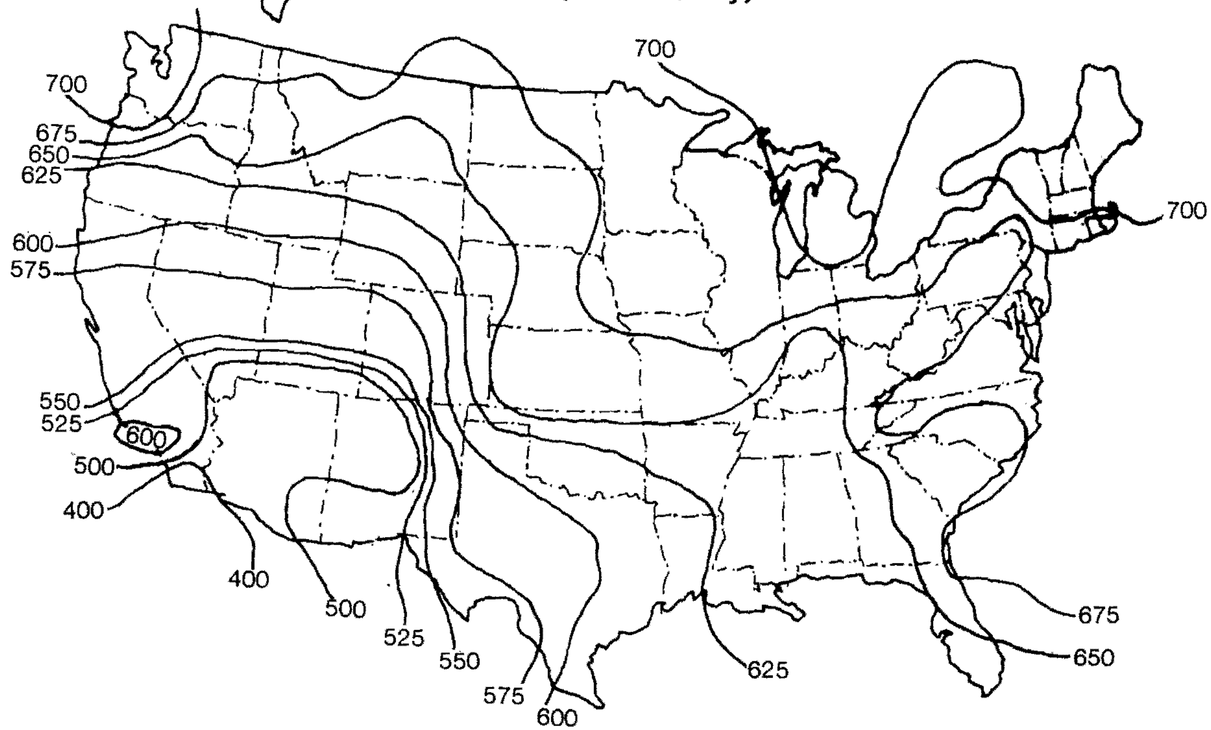
daily mean radiation, june





DIRECT RADIATION
JUNE DAY
on surface tilted to
Latitude + 20°
(BTU/ft²/day)

DIFFUSE RADIATION
JUNE DAY
on horizontal surface
(BTU/ft²/day)



MEAN DAILY RADIATION (BTU/FT²/DAY) FOR A SURFACE TILTED LATITUDE +20° = DIRECT RADIATION$_{TILT}$ + DIFFUSE RADIATION$_{HORIZ. \cong TILT}$

In the event that the solar collectors have been tilted to an angle optimal for winter radiation collection (latitude +20°), the amount of radiation actually received on the collector in summer may be *less* than the insolation values just given for a horizontal surface. To determine the actual radiation obtained on the tilted collector surface, add the direct radiation received at the latitude +20° tilt, to the diffuse radiation received. Collector surfaces tilted to an angle less than latitude +15 or 20° (or adjustable) will receive a greater amount of direct radiation during the summer cooling months, approaching the previous values of daily mean radiation on a horizontal surface.

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