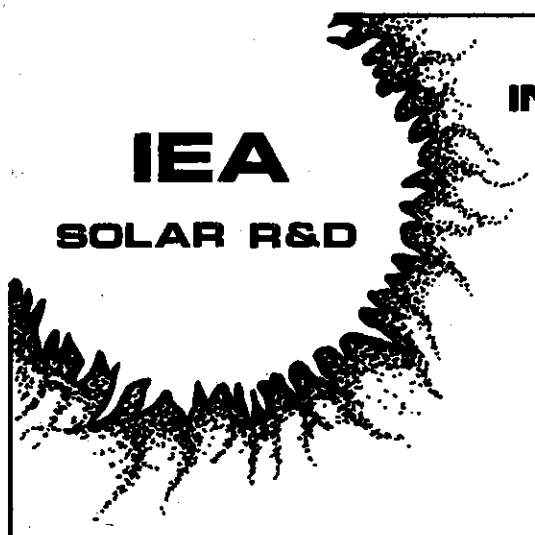


IEA

SOLAR R&D

INTERNATIONAL ENERGY AGENCY

program
to develop and test
solar heating
and cooling systems

task I

Instrumented Facilities Survey

for solar assisted low energy dwellings

february 1982

INTERNATIONAL ENERGY AGENCY

In order to strengthen cooperation in the vital area of energy policy, an Agreement on an International Energy Program was formulated among a number of industrialized countries in November 1974. The International Energy Agency (IEA) was established as an autonomous body within the Organization for Economic Cooperation and Development (OECD) to administer that agreement. Nineteen countries are currently members of the IEA, with the Commission of the European Communities participating under a special arrangement.

As one element of the International Energy Program, the participants undertake cooperative activities in energy research, development, and demonstration. A number of new and improved energy technologies which have the potential of making significant contributions to our energy needs were identified for collaborative efforts. The IEA Committee on Energy Research and Development (CRD), assisted by a small Secretariat, coordinates the energy research, development, and demonstration program.

Soler heating and cooling program

Solar Heating and Cooling was one of the technologies selected by the IEA for a collaborative effort. The objective was to undertake cooperative research, development, demonstrations and exchanges of information in order to advance the activities of all Participants in the field of solar heating and cooling systems. Several sub-projects or »tasks» were developed in key areas of solar heating and cooling. A formal Implementing Agreement for this Program, covering the contributions, obligations and rights of the Participants, as well as the scope of each task, was prepared and signed by 15 countries and the Commission of the European Communities. The overall program is managed by an Executive Committee, while the management of the subprojects is the responsibility of Operating Agents who act on behalf of the other Participants.

The tasks of the IEA Solar Heating and Cooling Program and their respective Operating Agents are:

I Investigation of the Performance of Solar Heating and Cooling Systems – Technical University of Denmark

II Coordination of R & D on Solar Heating and Cooling Components – Agency of Industrial Science and Technology, Japan

III Performance Testing of Solar Collectors – Kernforschungsanlage Julich, Federal Republic of Germany

IV Development of an Insolation Handbook and Instrumentation Package – United States Department of Energy

V Use of Existing Meteorological Information for Solar Energy Application – Swedish Meteorological and Hydrological Institute

VI Performance of Solar Heating, Cooling and Hot Water Systems using Evacuated Collectors – United States Department of Energy

VII Central Solar Heating Plants with Seasonal Storage – Swedish Council for Building Research

Collaboration in additional areas is likely to be considered as projects are completed or fruitful topics for cooperation identified.

Task I – Investigation of the performance of solar heating and cooling systems

In order to effectively assess the performance of solar heating and cooling systems and improve the cost-effectiveness of these systems, the participants in Task I have undertaken to establish common procedures for predicting, measuring, and reporting the thermal performance of systems and methods for designing economical, optimized systems. The results will be an increased understanding of system design and performance as well as reports and/or recommended formats on each of the task activities.

The subtasks of this project are:

A Assessment of modeling and simulation for predicting the performance of solar heating and cooling systems

B Development of recommended procedures for measuring system thermal performance

C Development of a format for reporting the performance of solar heating and cooling systems

D Development of a procedure for designing economical optimized systems

E Validation of simulation programs by comparison with measured data

F Solar-assisted low-energy dwellings

The participants in this task are: Belgium, Denmark, Germany, Italy, Japan, the Netherlands, New Zealand, Spain, Sweden, Switzerland, United Kingdom, United States, and the Commission of the European Communities.

INTERNATIONAL ENERGY AGENCY

Instrumented Facilities Survey

for solar
assisted
low energy
dwellings

This document was produced for the IEA by the United States Department of Energy with the assistance of Burt Hill Kosar Rittelmann Associates.

Butler, Pennsylvania

February 1982

BURT HILL
KOSAR
RITTELMANN
ASSOCIATES

ARCHITECTS

FORWARD

This publication of thirty-eight dwelling projects is the result of a survey conducted to identify projects and their associated instrumentation available in participating countries as a source of performance data. The survey was coordinated and compiled by the United States Department of Energy under the direction of the Operating Agent, Denmark. It represents one of the assigned items of work under Task I, Subtask (F) Solar-Assisted Low-Energy Dwellings (SALED).

The purpose of the survey is to permit the participating countries to identify selected instrumented solar assisted low energy dwellings as a starting point for obtaining performance data necessary to test and validate their performance simulations models. The specific applicability and appropriateness of the data from these projects for testing and validating simulation models cannot be assured. Additionally, many other instrumented projects exist and may be suitable to validation of simulation models. This survey of instrumented facilities is only a starting point to locate appropriate and usable performance data.

The survey form was designed to be in conformance with performance reporting procedures established by the CEC Performance Monitoring Group and the author is indebted to this group for their earlier work. Also, the author wishes to acknowledge the work of Task I, Subtask (C) Reporting Formats who have developed a standard reporting procedures and formats for thermal performance of solar heating and cooling systems in buildings. This format carefully describes the form the data should take to be useful to modelers for analysis and validation.

P. Richard Rittelmann
Representative for the
U.S. Department of Energy

The following document is a compilation of surveys outlining the instrumentation of thirty-eight active or passive solar projects in nine countries. For organization's sake, they have been arranged alphabetically by country. They have also been arranged alphabetically by project title within each country.

The first section is composed of the surveys themselves. The second section is a rearrangement of data compiled from the surveys. The rearrangement compares answers from similar survey questions for each of the thirty-eight projects. Since the survey was divided into distinct parts, such as climate, building and solar system description and meteorological, solar system and building system instrumentation capabilities, the data comparison in Section II is grouped in these subsets:

- Building Description
- Solar System Description
- Instrumentation Description
- Meteorological Instrumentation
- Solar System Instrumentation
- Building Instrumentation

SECTION I

DENMARK
- Hjortekaer C 1
- Hjortekaer F 4

ITALY
- Barra - Const. 7
- Habitat 10

JAPAN
- Aratani 13

NETHERLANDS
- Bouwcentrum 18

SWEDEN
- Bollebygd 22
- SUN SEC 25

SWITZERLAND
- Begnins 28
- Les Gen./Coff 31
- Payrne Active 34
- Renens Passive 37
- Stiftung Sonnen. 40

UNITED KINGDOM
- Linf. Milt. Keynes 43
- Linf. Milt. Keynes 2 46
- Linf. Milt. Keynes 3 49
- Low En. Hse. Lab (HP) 51
- Low En. Hse. Lab (Solar) 56
- Pennyland 61

UNITED STATES
- A-Frame Ind. 64
- Albuq. Western II 67
- Cathedral Sq. 70
- Fac. Development 73
- Forest City Dillon 76
- Hei Wai Wong 79
- Matt Cannon 83
- NBS Passive 86
- Saddle Hill 36 89
- Saddle Hill 77 93
- Sir Galahad Co. 96
- Solar House I 99
- Solar House II 102
- Stewart-Teele-Mitchell 105

WEST GERMANY
- Aachen Solar House 108
- Deizisau Sol. House 111
- Essen Solar House 114
- FHT Solar House 116
- Freiburg Solar House 120

SECTION II

BUILDING DESCRIPTION 123
SOLAR SYSTEM DESCRIPTION 126
INSTRUMENTATION DESCRIPTION 128
METEOROLOGICAL INSTRUMENTATION 129
SOLAR SYSTEM INSTRUMENTATION 130
BUILDING INSTRUMENTATION 132

SECTION I

DENMARK

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Hjortekaer, House C

Address: Proevekaeret
2800 Lyngby
Denmark

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	M. Byberg Thermal Insulation Lab. Technical University of Denmark. DK-2800 Lyngby Denmark 2 883511	Hom Huse Ltd. Oremosegaard 9870 Sindal (08) 935700	Vibe-Hansen & Lomborg Ltd. Østeraa 19 9000 Aalborg (08) 126077
Responsibility	Coordination	Construction	

PROJECT DESCRIPTION

CLIMATE

Latitude 55 N Longitude -13 E Altitude ~ sea level DD 2829 Base Temp. 17

Sunshine Hours July 226 January 70 Annual 1580

Source of data Danish "Test Reference Year"

Urban ____ Suburban X Rural ____

BUILDING

Floor area 135 m^2 No. Occupants 4 (simulated)

Design Temperature internal w 21 s 26 °C

external w -12 s - °C

Mass type concrete location floor

South Glazing type 3 layers thermo-panes + 1 outside layer on all non-moveable windows

area(south glass) 13.3 m^2 % of total glass 55%

night insulation - shaded S:100% W:0%

Heated Volume 268.3 m^3 Ventilation Rate 206 m^3/h a.c.h.

exhaust air heat recovery

SOLAR SYSTEM

System energy use(eg. heating) (Floor)-heating and DHW

Collector type Tube and fin flat plate area(net) 20 m^2

orientation due South tilt 45°

Storage type Water tank capacity 1.8 m^3

Auxiliary System type Electricity fuel type ____ fuel cost 10 ¢/kWh

+ heat pump: exhaust air - DHW (after heat-exchanger)

PROJECT SCHEDULE

MILESTONES \ DATE	1977	1978	1979	1980	1981	1982
Construction completion		X				
Monitoring period			sim.hab.	non-occupied		
Final reports					X	X

Report availability — Title (available from): Six low-energy houses at Hjortekaer, May 1979 — Thermal Insulation Laboratory

INSTRUMENTATION (existing or anticipated)

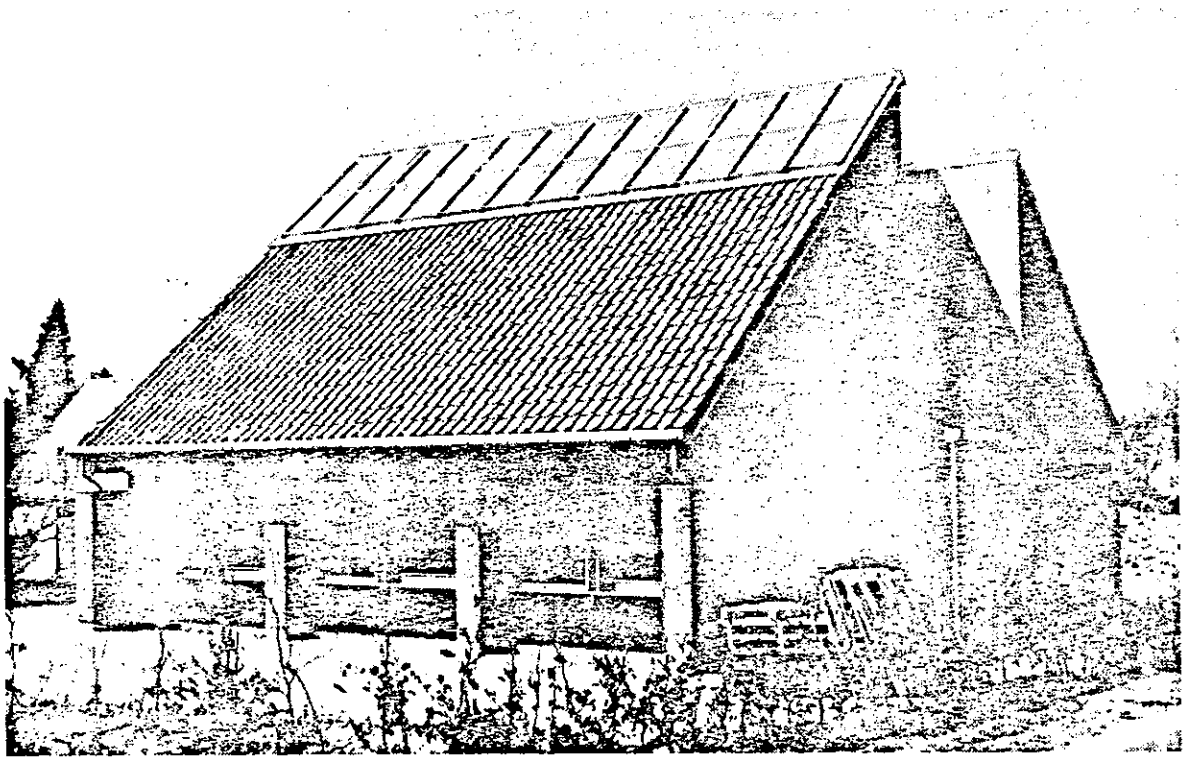
Approximate cost of instrumentation package: 27,000-36,000 $

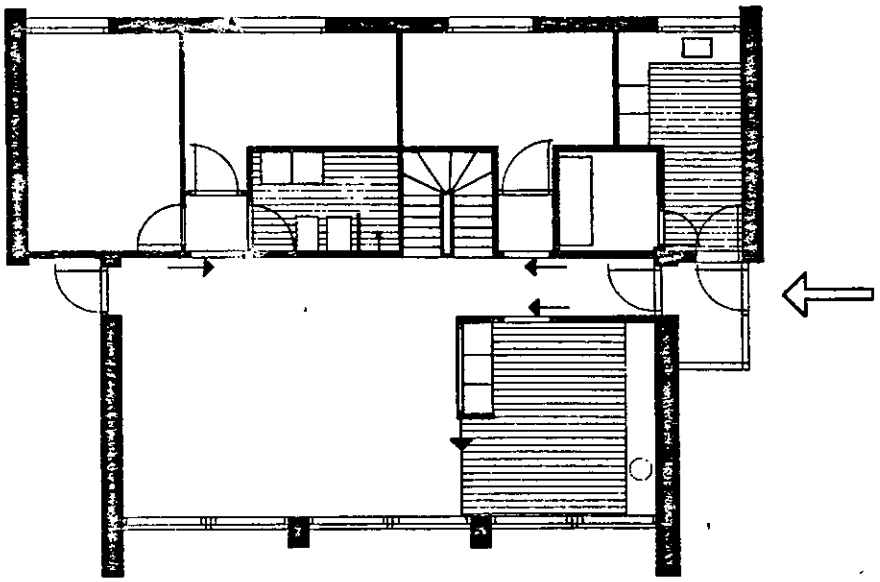
Description of data recording method: 10 min data first stored on cassettes for each 3 days period then transferred to hard discs (1 month each)

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	10 sec.	
	Outdoor Temperature	10 sec.	
	Incident radiation on horizontal surface	10 sec.	
	Diffuse - - - Incident radiation in plane of collector	10 sec.	
	Relative Humidity	10 sec.	
	Wind Speed	10 sec.	
	Wind direction	10 sec.	
	Radiation on vertical south, east and west	10 sec.	
SOLAR SYSTEM	Collectors		Temperatures are measured with a resolution of .3 °C and an accuracy of .5 °C
	Flow rate entering collectors	10 min.	
	Temperature entering & leaving collectors	10 min.	
	Storage		
	Flow rate inputs to storage	10 min.	Flowrates:
	Temperature entering & leaving storage	10 min.	Resolution 12-25% (10 m
	Temperature readings in storage(1 or more)	10 min.	Accuracy 1-2% (day)
	Auxiliary energy supplied to storage	-	
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	10 min.	
	Temperature entering & leaving subsystems	10 min.	Resolution and
	Auxiliary energy supplied to subsystems	10 min.	accuracy: 6-12% (10 min) 1-2% (day)
BUILDING SYSTEM	Average DB inside temperature (all rooms separately)	10 min.	
	~~Infiltration~~ load (ventilation)	10 - 20 min.	5%
	Auxiliary energy	10 min.	
	Operating energy	10 min.	
	Total building energy load	10 min.	
	Internal energy gains (simulated)	10 min.	
	Solar gains	10 min.	
	Solar as a % of total load		
	Thermal capacity of building		

ILLUSTRATION





IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Hjortekaer, House F

Address: Provekaeret
2800 Lyngby
Denmark

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	M. Byberg Thermal insulation Lab. Technical University of Denmark DK-2800 Lyngby Denmark 2 883511	Højgaard & Schultz Jægersborg Allé 4 2920 Charlottenlund (01)631212	Cowiconsult Ltd. Teknikerbyen 45 2830 Virum (02)857311
Responsibility	Coordination	Construction	Consulting engineers

PROJECT DESCRIPTION

CLIMATE

Latitude 55 N Longitude 13 E Altitude sea level DD 2889 Base Temp. 17

Sunshine Hours July 226 January 70 Annual 1580

Source of data Danish "Test Reference Year"

Urban ____ Suburban X Rural ____

BUILDING

Floor area 88 x 2 m^2 + basement No. Occupants 4 (simulated)

Design Temperature internal w 21 s 26 °C

external w -12 s - °C

Mass type Concrete location walls, floors, ceiling

South Glazing type 3 layers thermo panes

area(south glass) 25.4 m^2 % of total glass 93%

night insulation aut.shutters shaded S: 90%, W: 0%

Heated Volume 350 m^3/h Ventilation Rate 200 m^3/h a.c.h.

exhaust air heat recovery

SOLAR SYSTEM

System energy use(eg. heating) Floor-heating and DHW

Collector type Aluminium tube and fin, 1 g $A_{area(net)}$ 19 m^2

orientation due south tilt 45°

Storage type water tank capacity 1.5 m^3

Auxiliary System type gas-boiler fuel type gas fuel cost ____

PROJECT SCHEDULE

MILESTONES \ DATE	1977	1978	1979	1980	1981	1982
Construction completion			X			
Monitoring period			sim.hab.	occupied		
Final reports					X	X

Report availability — Title (available from): Simulated occupation in 6 Low-energy ~~Dwellings in Hjortekaer ?~~ ~~Thermal Insulation Laboratory~~

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: 27,000-36,000 $

Description of data recording method: 10 min. data first stored on cassettes for each 3 days period then transferred to hard discs (1 month each)

DATA RECORDED

METEOROLOICAL

	Frequency of data recording	Accuracy of instrument
Degree Days	10 sec.	
Outdoor Temperature	10 sec.	
Incident radiation on horizontal surface	10 sec.	
Diffuse - ~~Incident radiation in plane of collector~~	10 sec.	
Relative Humidity	10 sec.	
Wind Speed	10 sec.	
Wind direction	10 sec.	
Radiation on vertical sourth, east and west	10 sec.	

SOLAR SYSTEM

Temperatures are measured with a resolution of .3° C and an accuracy of .5° C

Collectors	
Flow rate entering collectors	10 min.
Temperature entering & leaving collectors	10 min.
Storage	
Flow rate inputs to storage	10 min.
Temperature entering & leaving storage	10 min.
Temperature readings in storage(1 or more)	10 min.
Auxiliary energy supplied to storage	
Space heat,Space cooling,Hot water Subsystems	
Flow rates entering subsystems	10 min.
Temperature entering & leaving subsystems	10 min.
Auxiliary energy supplied to subsystems	10 min.

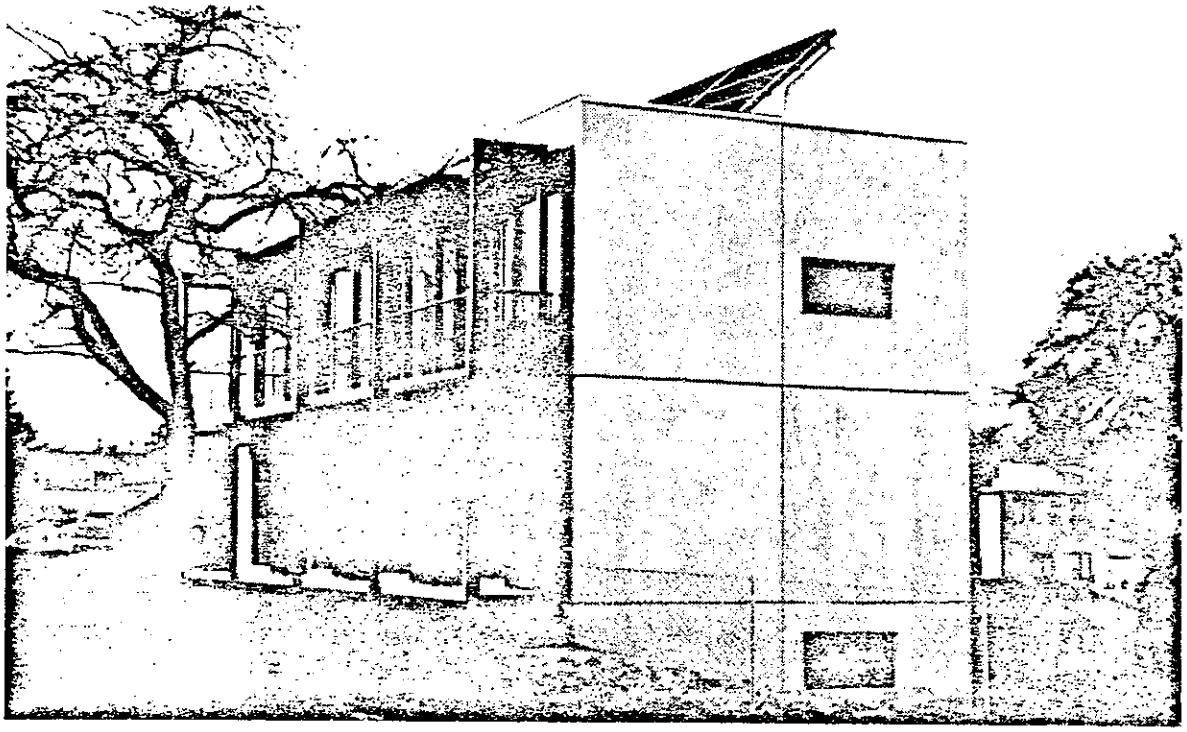
Flowrates:
Resolution 12-25% (10 min)
Accuracy 1-2% (day)

Resolution and accuracy: 6-12 (10 min) 1-2% (day)

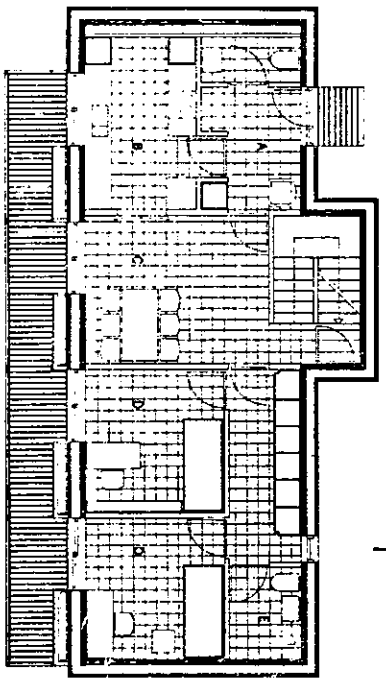
BUILDING SYSTEM

Average DB inside temperature	(all rooms separately) 10 min.	
~~Infiltration~~ load (ventilation)	10 - 20 min.	5%
Auxiliary energy	10 min.	
Operating energy	10 min.	
Total building energy load	10 min.	
Internal energy gains (simulated)	10 min.	
Solar gains	10 min.	
Solar as a % of total load		
Thermal capacity of building		

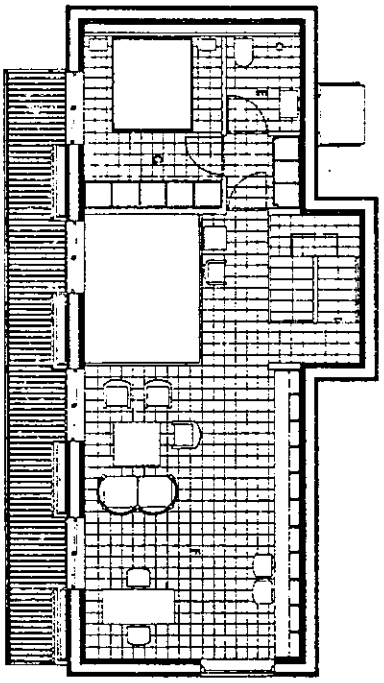
ILLUSTRATION



Ground floor



First floor



N

ITALY

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

The Barra-Costantini Solar Passive System

Address: Salisano (Rieti) - Italy

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Prof. Orazio A. Barra Dipartimento di Fisica- Universiya di Calabria - 87030 - Cosenza (Italy) 0984 - 839389	Dr. Tommaso Costantini Casa Solare - Salisano (Rieti) - Italy	
Responsibility	Chief of the project	Executive Chief	

PROJECT DESCRIPTION

CLIMATE

Latitude 42° 15'N Longitude 12° 45' Altitude 300 M DD 1800 Base Temp. 0°C

Sunshine Hours July 337 January 127 Annual 2518

Source of data

Urban ____ Suburban ____ Rural x

BUILDING

Floor area 130 M^2 No. Occupants 2

Design Temperature internal w ____ s ____ °

external w ____ s ____ °

Internal = 19°C, External hourly simulated by computer using the available meterol. data

Mass type concrete ceilings & lecablock walls location

South Glazing type double glass

area(south glass) 15 M^2 % of total glass 60%

night insulation yes shaded

Heated Volume 380 M^3 Ventilation Rate 1 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Barra-Costantini System (solar chimneys on the south wall & storage in ceiling slobs)

Collector type solar chimneys on the south wall area(net) 30M^2

orientation south tilt vertical

Storage type in the ceilings having hot air channels inside capacity 900 KJoule/oc per m^2 of coll. +1700 " " "

Auxiliary System type wood chimney fuel type wood the house structur fuel cost

PROJECT SCHEDULE

MILESTONES \ DATE	1979	1980	1981	1982		
Construction completion	X					
Monitoring period		X	X	X		
Final reports	X	X	X	X		

Report availability (available from) Title

1) A theorectical study..., Solar Energy 23, 211 (1979)
2) The Barra-Costantini..., Proc. Cong. Buil. Eu. Meudj., Povoa de Verrim (Portugal), edited by Perganon Press (1980)
3) A well natural connection..., Energy and Buildings, in press

INSTRUMENTATION (existing or anticipated)

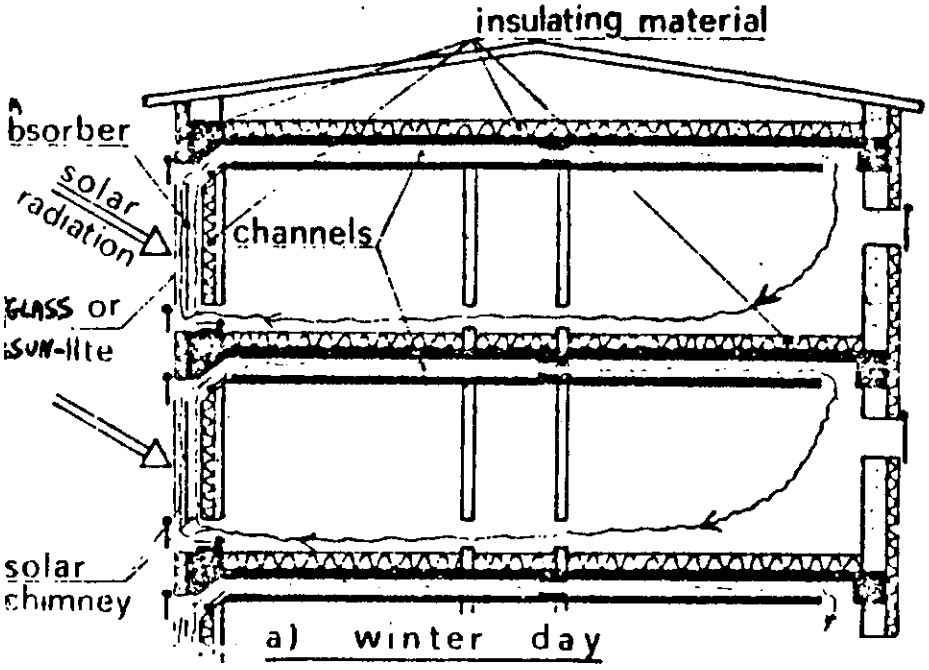
Approximate cost of instrumentation package: 6000 U.S.$

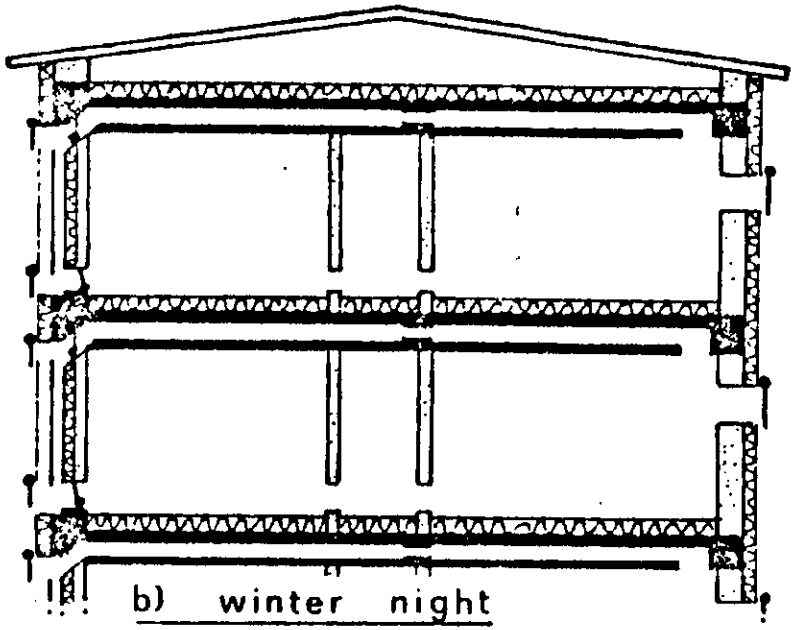
Description of data recording method: Data logger and chart recorders, or manual

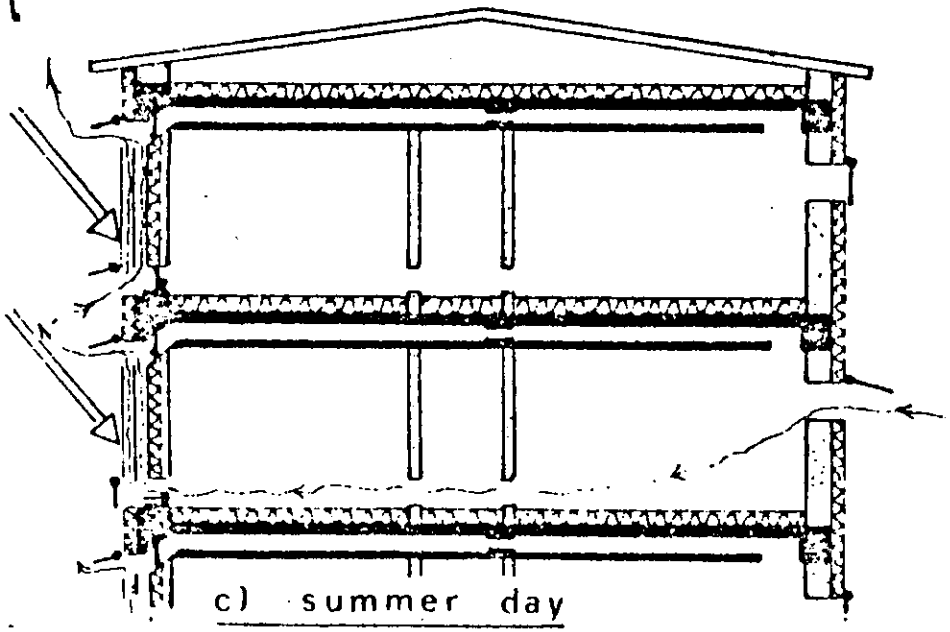
DATA RECORDED

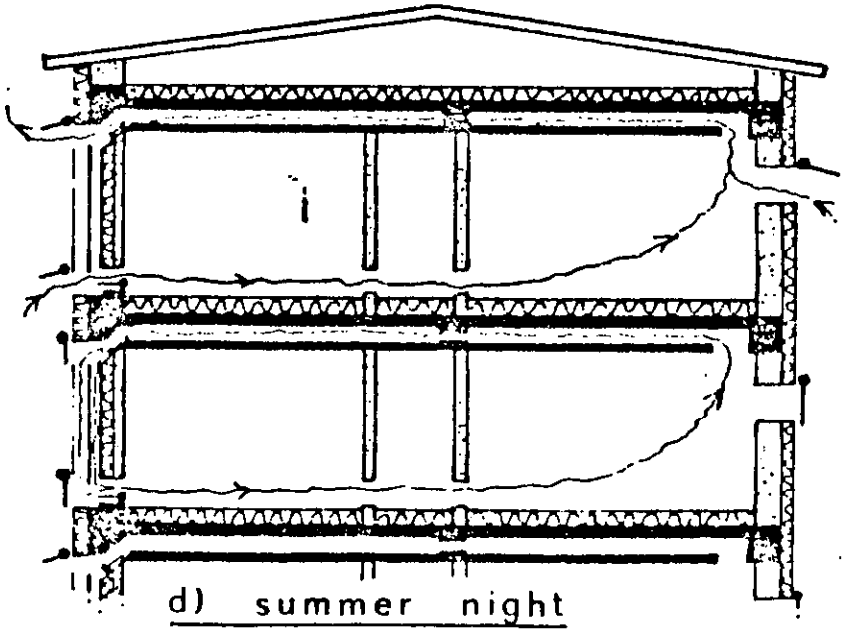
		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days		
	Outdoor Temperature	hourly	± 1°C
	Incident radiation on horizontal surface		
	Incident radiation in plane of collector	hourly	± 50 W/M²
	Relative Humidity	Furnished by the national	
	Wind Speed	existing meteorological stations	
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	hourly	± 5 CM/sec
	Temperature entering & leaving collectors	hourly	± 1°C
	Storage		
	Flow rate inputs to storage	hourly	± 5 CM/sec
	Temperature entering & leaving storage	hourly	± 1°C
	Temperature readings in storage(1 or more)	hourly (24 sensors)	± 1°C
	Auxiliary energy supplied to storage		
	Space heat, Space cooling, Hot water Subsystems		
	Flow rates entering subsystems	hourly	± 5 CM/sec
	Temperature entering & leaving subsystems	hourly	± 1°C
	Auxiliary energy supplied to subsystems		
BUILDING SYSTEM	Average DB inside temperature	hourly	± 1°C
	Infiltration load		
	Auxiliary energy	daily	Kg of fuel
	Operating energy		
	Total building energy load	monthly	
	Internal energy gains	monthly	
	Solar gains	monthly	
	Solar as a % of total load	monthly	
	Thermal capacity of building	evaluated	

ILLUSTRATION









IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

"HABITAT"

Address

JRC
21020 ISPRA (VA)
ITALY

MAIN PARTICIPANTS

	1	2	3
Name Address	Commission of the European Communities JRC I-21020 ISPRA (VA)		
Phone	0332/780 131		
Responsibility	E. ARANOVITCH		

PROJECT DESCRIPTION

CLIMATE

Latitude 45° 48' Longitude 8° 37' Altitude 230m DD 2600 Base Temp. 20°C

Sunshine Hours July _____ January _____ Annual _____

Source of data meteorological observatory

Urban ____ Suburban X Rural ____

BUILDING

Floor area 160 m^2 No. Occupants 3

Design Temperature internal w 20 s _____ °C

external w -12 s _____ °

Mass type masonry; concrete location walls; floor

South Glazing type double glazing

area(south glass) 8,4 m^2 % of total glass ≈ 40 %

night insulation --- shaded during summer

Heated Volume 320m^3 Ventilation Rate variable a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) house heating

Collector type different types area(net) 41 m^2

orientation south tilt 60°

Storage type a) water tank; b) bassin water capacity a) 2m^2 b) 50m^3

Auxiliary System type heatpump water to water fuel type electricity fuel cost ---

PROJECT SCHEDULE

MILESTONES \ DATE						
Construction completion	in operation since 1977					
Monitoring period						
Final reports						

Report availability — Title (available from): see annex

INSTRUMENTATION (existing or anticipated)

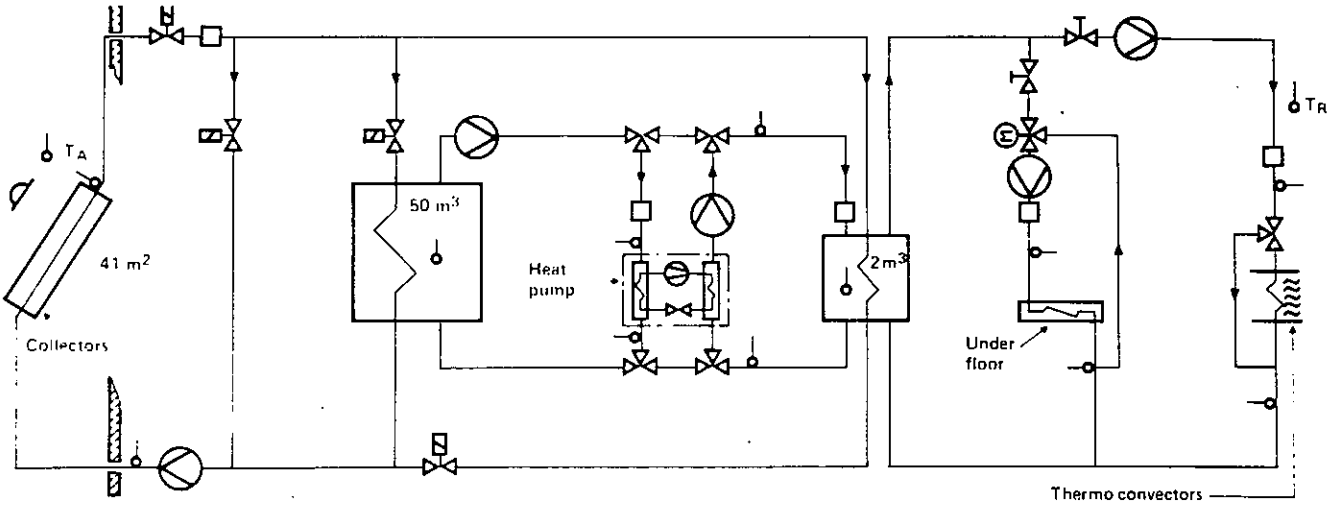
Approximate cost of instrumentation package: 40 000 US $

Description of data recording method: computer based data acquisition system; Hewlett-Packard 3052 A

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	every min.	± 0,1 °C
	Outdoor Temperature	"	± 0,1 °C
	Incident radiation on horizontal surface	"	± 10 W/m²
	Incident radiation in plane of collector	"	± 10 W/m²
	Relative Humidity	"	± 5 %
	Wind Speed	cont.	± 10%
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	every min.	± 15 l/h
	Temperature entering & leaving collectors	"	± 0,1 °C
	Storage		
	Flow rate inputs to storage	"	± 10 l/h
	Temperature entering & leaving storage	"	± 0,1 °C
	Temperature readings in storage(1 or more)	"	± 0,1 °C
	Auxiliary energy supplied to storage	"	± 1%
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	"	± 1%
	Temperature entering & leaving subsystems	"	± 0,1%
	Auxiliary energy supplied to subsystems	"	± 1%
BUILDING SYSTEM	Average DB inside temperature	every min.	± 0,1%
	Infiltration load	---	---
	Auxiliary energy	every min	± 1%
	Operating energy	"	± 1%
	Total building energy load	"	± 2%
	Internal energy gains	daily	± 1%
	Solar gains	evaluated	
	Solar as a % of total load	idem	
	Thermal capacity of building	---	---

ILLUSTRATION



Hybrid Solar Heating System of the JRC Solar Laboratory

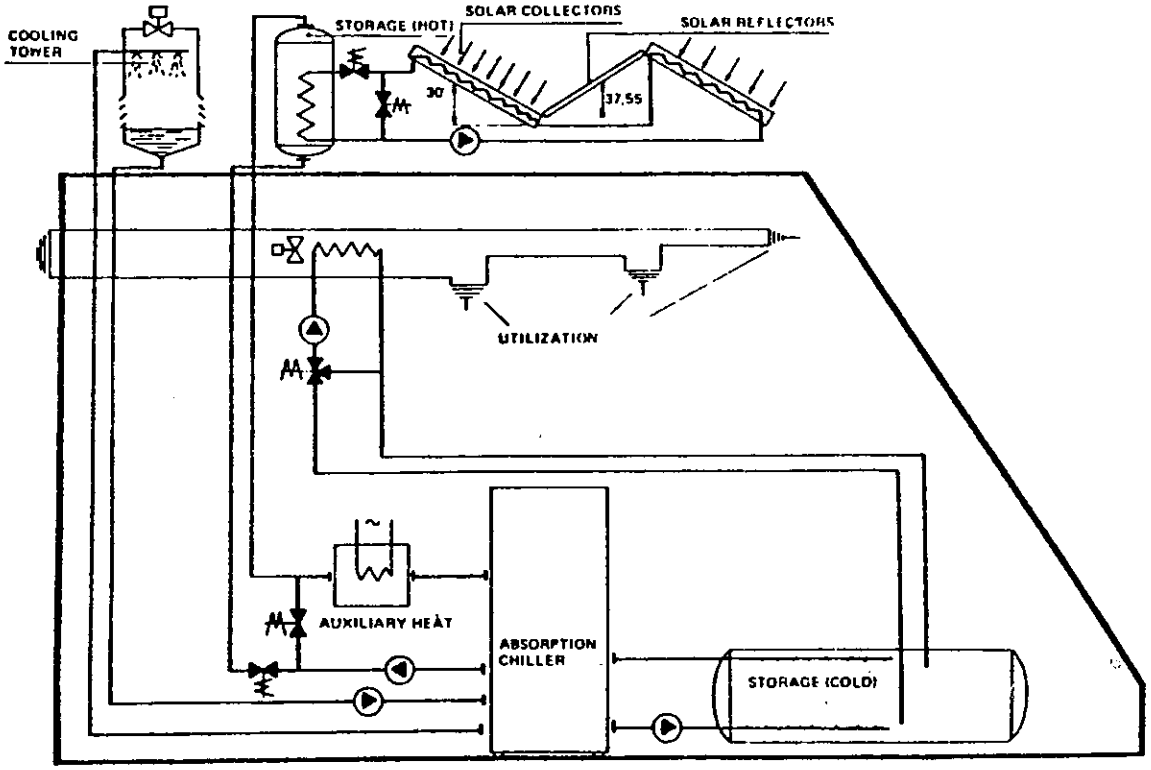


Fig.3 Schematic view of the solar cooling system of the JCR Solar laboratory.

JAPAN

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Aratani house [Architectural use of Solar Radiation in Winter and Natural Cooling in Summer]

Address

Teine-honcho 462, Nishi-ku Sapporo
Japan

MAIN PARTICIPANTS

	1	2	3
Name	Noboru Aratani		
Address	Teine-honcho 462 Nishi-ku Sapporo		
Phone	011-683-7630		
Responsibility	Designer, Researcher Resident		

PROJECT DESCRIPTION

CLIMATE

Latitude 43°N **Longitude** 141°E **Altitude** 15m **DD** 3970 **Base Temp.** 18°C

Sunshine Hours July 194 January 101 Annual 1954

Source of data Scientific chronology edited by Tokyo Astronomical Observatory

Urban ____ **Suburban** x **Rural** ____

BUILDING

Floor area 320 m² **No. Occupants** 8 (two families)

Design Temperature internal w 18 s 28 °C

external w -12 s 32 °C

Mass type cement concrete blocks location construction wall

South Glazing type triple triple glass + long wave reflective film

area(south glass) 54 m² % of total glass 77%

night insulation 38mm insulation board (unfinished) shaded horizontal louver (south)

Heated Volume 912 m³ Ventilation Rate 0.33 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Heating (through the windows) - Hot water (by the collectors)

		Heating	Hot Water
Collector	type triple glass window plate collector	area(net) 54 m²	4.5 m²
	orientation south south	tilt 90°	67°
Storage	type construction wall water tank	capacity 46000kcal/k 230ℓx2	
Auxiliary System	type water heating system waste heat boiler	fuel type oil	fuel cost waste
		80 yen/ℓ	free

PROJECT SCHEDULE

MILESTONES \ DATE	Oct. 30, 1979	Jan., 1980				
Construction completion	o					
Monitoring period		o		continued		
Final reports						unfinished

Report availability — **Title (available from)**: Thermal on Ventilative Test Results of the Highly Insulated House. T. Sasaki, N. Aratani, 1980. Architectural Institute of Japan

INSTRUMENTATION (existing or anticipated)

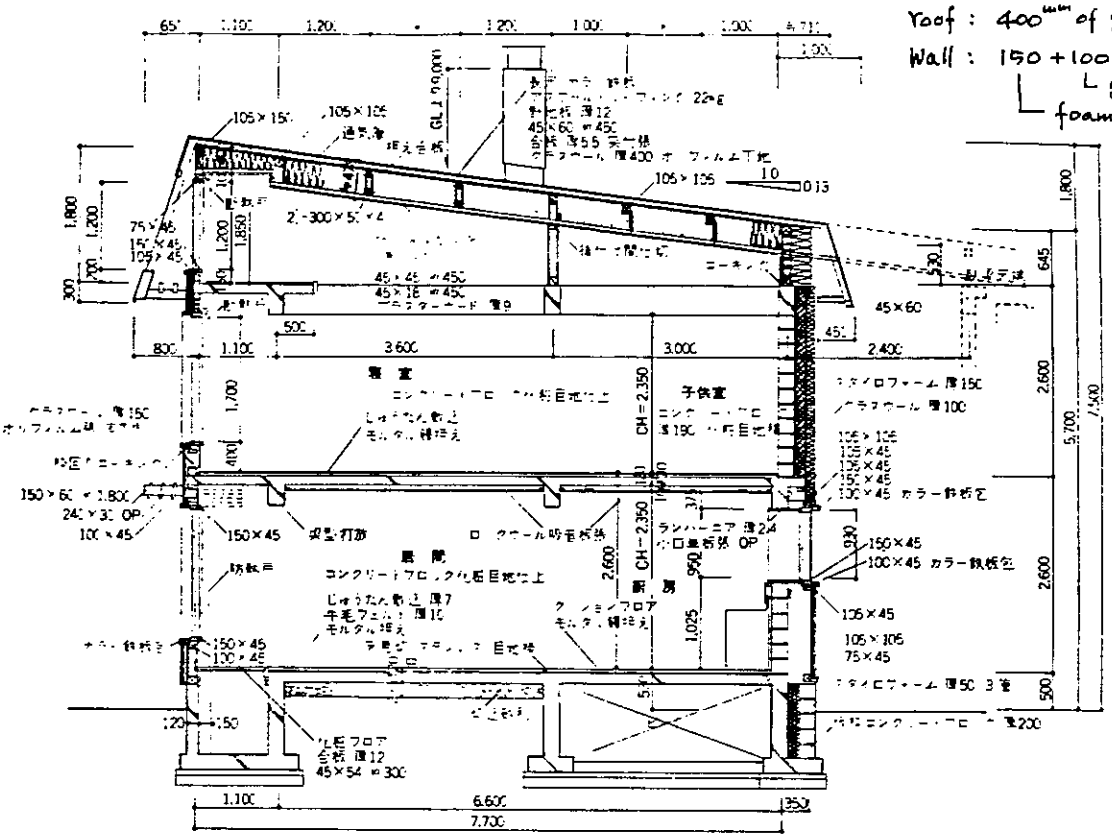
Approximate cost of instrumentation package: ____

Description of data recording method: Thermo couple + multi point recorder; Eply radiometer + Integrator + recorder

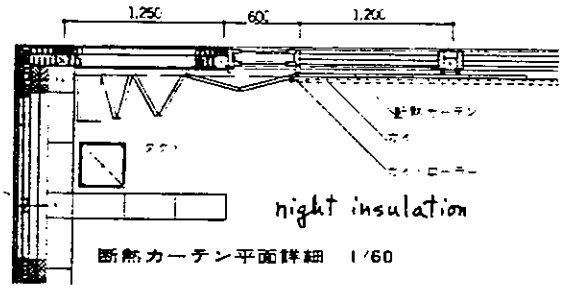
DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	continued	good
	Outdoor Temperature	continued	good
	Incident radiation on horizontal surface	---	---
	Incident radiation in plane of collector	continued	good
	Relative Humidity	---	---
	Wind Speed	---	---
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	---	
	Temperature entering & leaving collectors	---	
	Storage		
	Flow rate inputs to storage	---	
	Temperature entering & leaving storage	---	
	Temperature readings in storage(1 or more)	6 points - continued	
	Auxiliary energy supplied to storage	---	
	Space heat, Space cooling, Hot water Subsystems		
	Flow rates entering subsystems	---	
	Temperature entering & leaving subsystems	---	
	Auxiliary energy supplied to subsystems	once a day	
BUILDING SYSTEM	Average DB inside temperature	continued	good
	Infiltration load	3 times/season	
	Auxiliary energy	once a day	
	Operating energy	---	
	Total building energy load	once a month	
	Internal energy gains		
	Solar gains (80% of total load for heating)		
	Solar as a % of total load		
	Thermal capacity of building	estimated	

Insulation
Roof : 400mm of grass wool
Wall : 150 + 100
└ grass wool
└ foam polystyrene

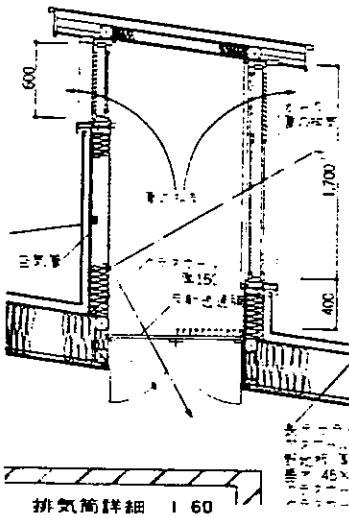


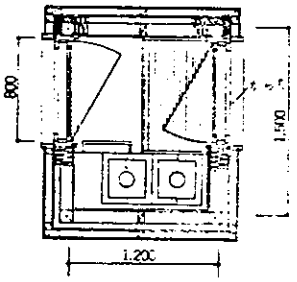
矩計詳細 1/100



night insulation

断熱カーテン平面詳細 1/60

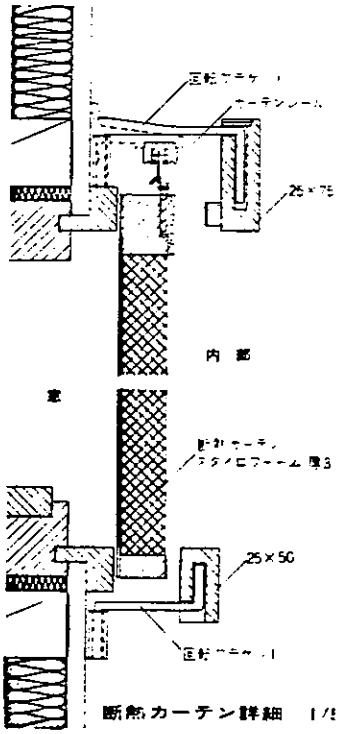




排気筒平面詳細 1/60

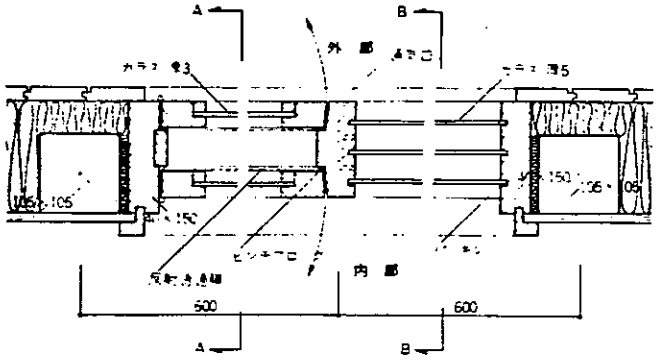
natural ventilation tower
for night ventilation

排気筒詳細 1/60

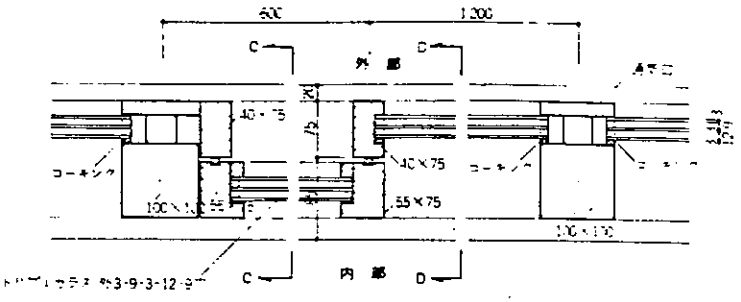


断熱カーテン詳細 1/

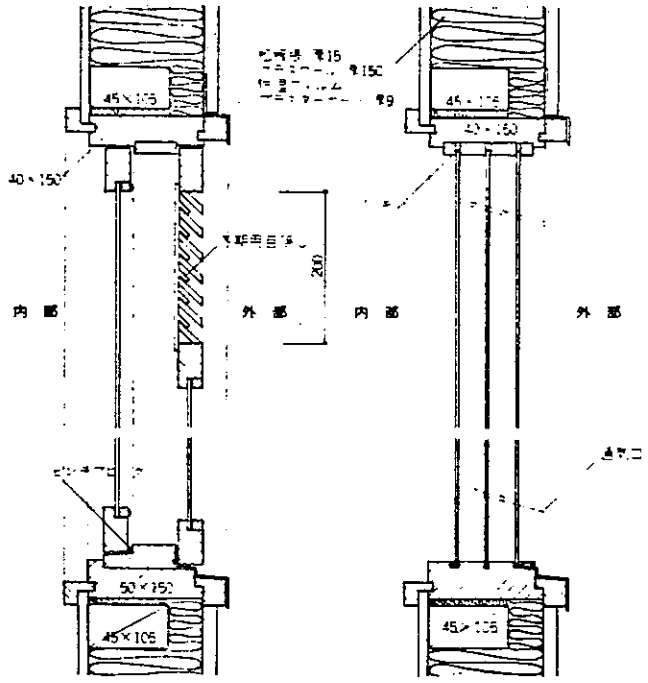
Photos: T. Waki



南側1，2階窓詳細　1/10

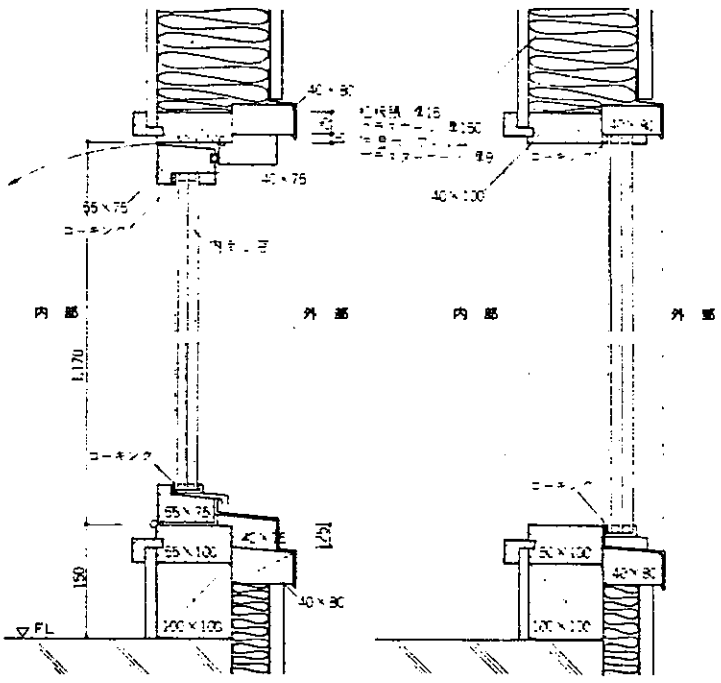


南側高熱窓詳細　1/10



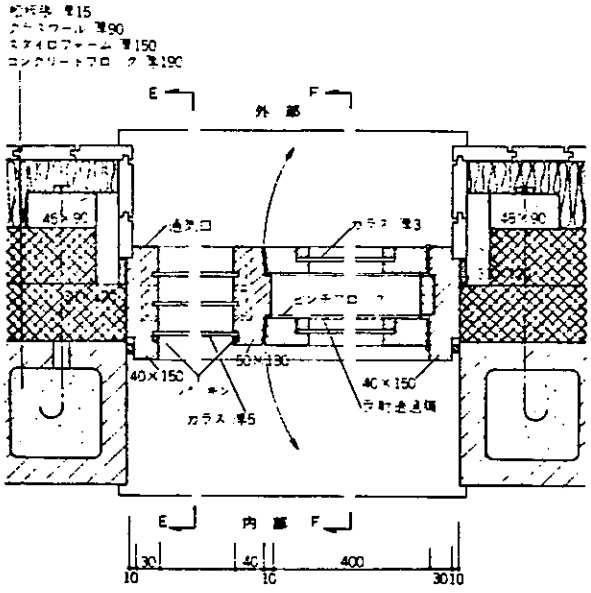
A-A断面　1/10

B-B断面　1/10

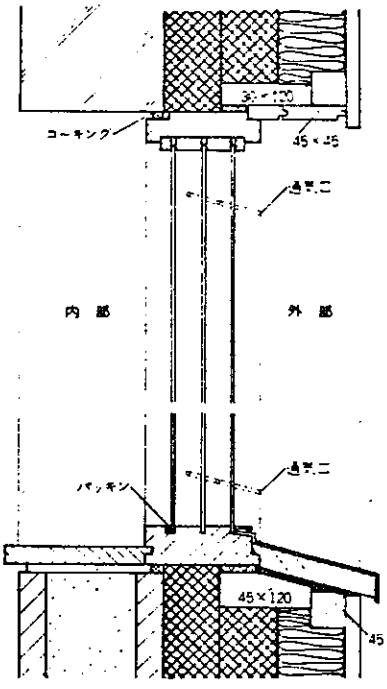


C-C断面　1/10

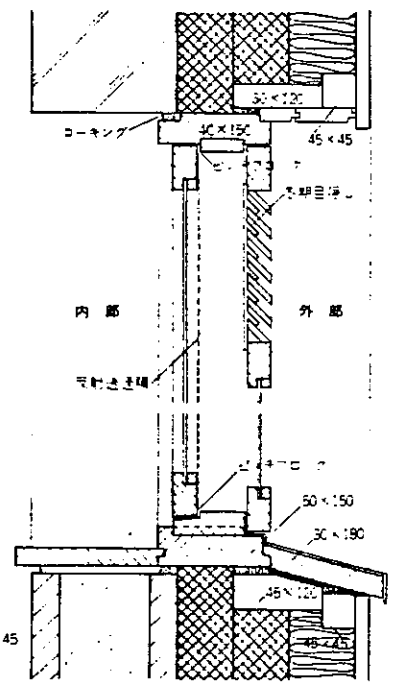
D-D断面　1/10



北側窓詳細　1/10



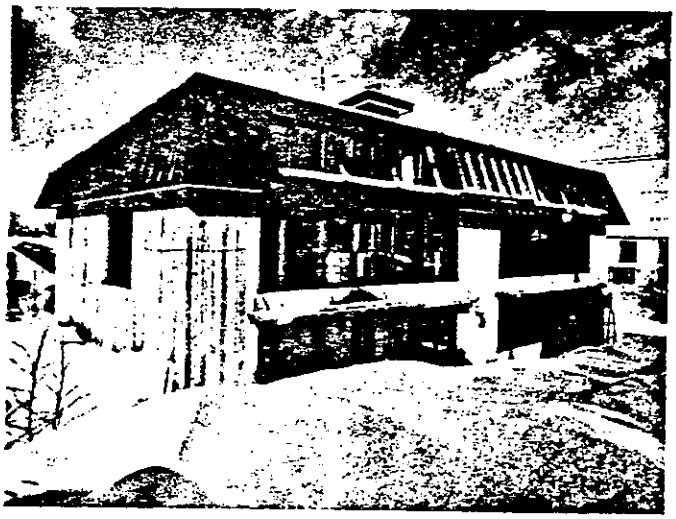
E-E断面　1/10

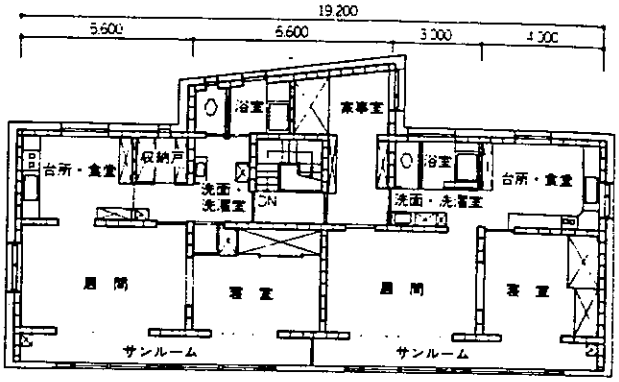


F-F断面　1/10

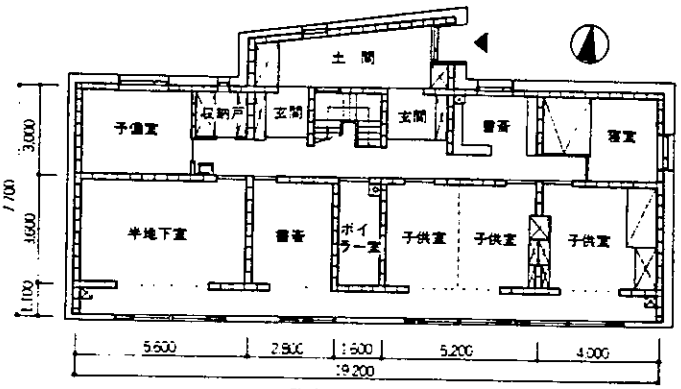
太陽熱の建築的な利用

荒谷昭／荒谷登（北海道大学）





2階平面 2nd floor



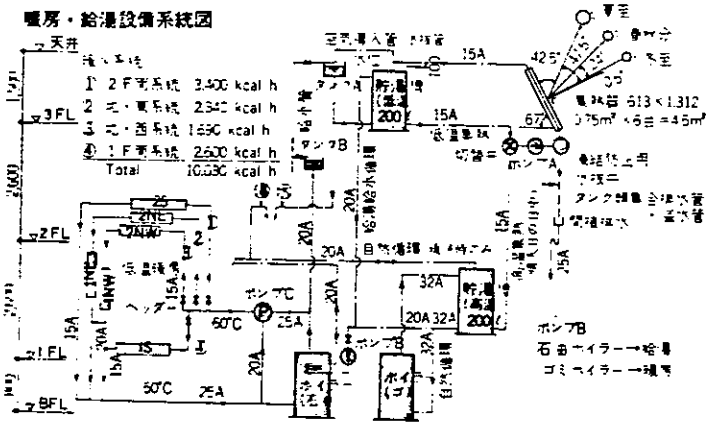
1/100

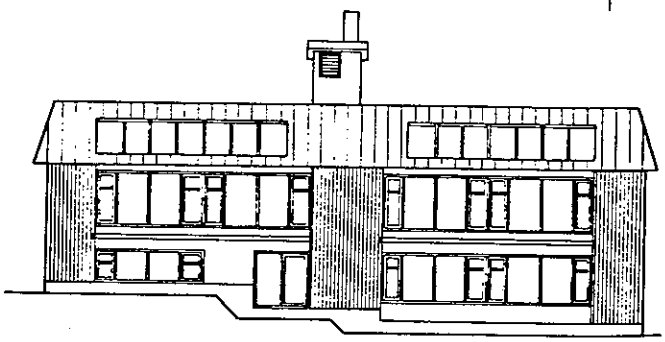
1階平面 1/250 1st floor

所在／札幌市・手稲
敷地面積／946m²
建築面積／161.7m²
延床面積／323.4m²
1階：161.7m²
2階：161.7m²

施工／常雪工業
暖房機器／スウェーデン製低温水ボイラー＋PS・HR ヒーター（放熱器）。給湯熱源として前ボイラーおよび太陽熱コレクター

暖房・給湯設備系統図





南側立面 1/250 South elev.

作者は，北海道の寒地住宅の研究の中で，主として環境工学的な立場からの理論を支える中心的な存在として役割を果たしている。日本の建築，特に住宅建築の分野において，研究者や各種の分野の専門家にとって互いに協力し合いながら，実験的な住宅を造りあげるという機会はきわめて少ない。

この住宅は，氏の研究の実験室であり，また自らが住み手となってその成果の確認と次への問題を発見する場となっている。その意味からも未完成品と自認されるが，盛り込まれた主張は明快であり，強い説得力をもつものである。この住宅にしつらえられた装置は，家の大きさからみれば非常に小さい給湯補助熱源としての太陽熱コレクターと，スウェーデン製の熱効率95%という高性能ボイラーと約50°C くらいで放熱するパネルラジエーターを除くと，まさに建築的な手法に彩られている。

ブロック造の開口部の不自由さから逃れるための木造のカーテンウォール，そこに南面一杯にとられた木製枠による三重ガラス窓，その窓から入る太陽熱を吸・放熱するためのブロック壁とRCスラブ，内部の熱を逃がさないための徹底した高断熱化された壁と屋根と断熱カーテン，さらに南面にできる縁側均スペースを含めたオープンなプランニングを床下にまで広げ，基礎断熱された床下の地盤蓄熱の利用等によって，この広い住宅が，北海道の普通の暖房面積 30～40m² の住宅の約半分の灯油消費で隅々まで終日暖房されるということは，特に北海道の人びとにとって驚異であろう。注目すべきは，17～18°Cという普通よりは 5°C くらい低めの設定温度でまったく寒さを感じない内部空間は，現在は竣工直後のためか多少湿度が高いが，外断熱と熱容量の大きい部位構成と低温水による終日暖房の成果といえる。安上がりで工夫に富む開口部まわりや断熱のディテールは，熱・空気の理論を熟知した者のみが行ないうる確かさと，大量生産部品に対するアンチテーゼが感じられる。

普及という点からは，まだ解決しなければならない点もあるが，最初に述べたとおり，これは氏の研究，実験の場なのである。

THE NETHERLANDS

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

BOUWCENTRUM SOLAR HOUSE Type II

Address: Zundert (The Netherlands)

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Bouwcentrum Binnenmilieutechniek Weena 700 P.O.Box 299 3000 AG ROTTERDAM	Technisch Physische Dienst TNO-TH Stieltjesweg 1 P.O.Box 1 2628 CK DELFT	
Responsibility	Bouwcentrum		

PROJECT DESCRIPTION

CLIMATE

Latitude 51°5' Longitude 5°7' Altitude +5 DD 3644 Base Temp. 18°C

Sunshine Hours July 225 January 73 Annual 1400

Source of data Kon. Ned. Meteorologisch Instituut De Bilt

Urban ____ Suburban X Rural ____

BUILDING

Floor area 230 m^2 No. Occupants 4

Design Temperature internal w 20 s ____ °C

external w -10 s ____ °C

Mass type concrete,bricks location Zundert

South Glazing type insul.double glazing(U-value 1.7 $W/m^2.K$)

area(south glass) 21,6 m^2 % of total glass 45%

night insulation -- shaded --

Heated Volume 660 m^3 Ventilation Rate 0,5 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) air collector with integrated heat storage

Collector type see above area(net) 30 m^2

orientation south tilt 55°

Storage type concrete slab 120 mm thick capacity 5,8 MJ

Auxiliary System type air heater fuel type gas fuel cost ____

PROJECT SCHEDULE

MILESTONES \ DATE						
Construction completion						
Monitoring period		March '80	-- Oct.'81			
Final reports				Dec. '81		

Report availability — Title (available from): December 1981

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: Dfl.50.000,--

Description of data recording method: Microprocessor controlled data-logger data storage on cartridge

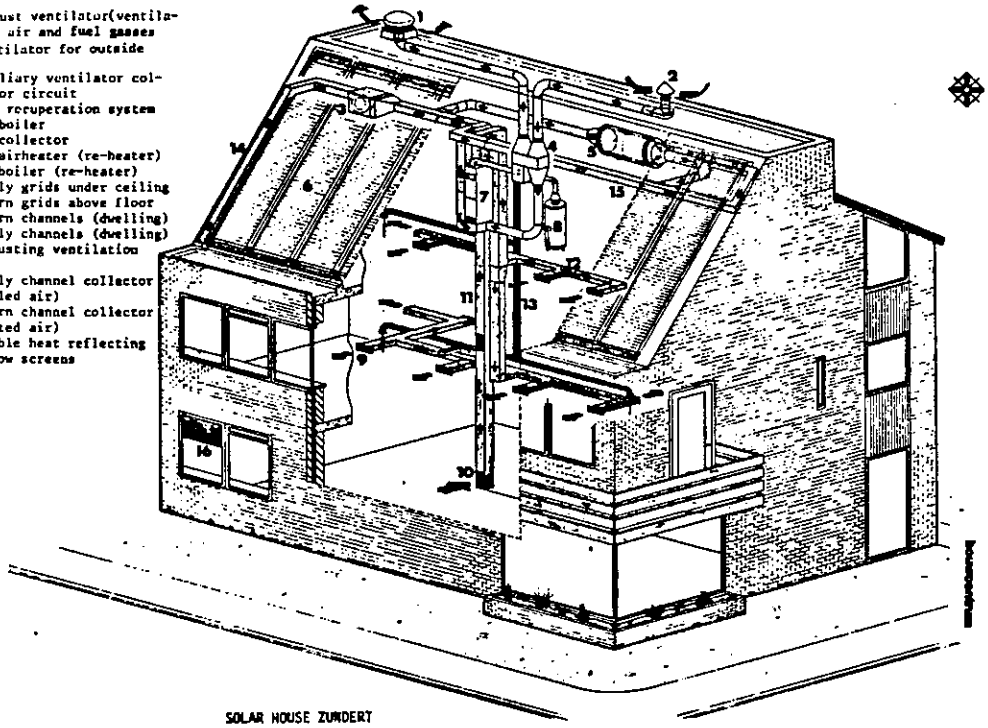
DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	--	
	Outdoor Temperature	7 sec.	1%
	Incident radiation on horizontal surface	--	
	Incident radiation in plane of collector	7 sec.	2%
	Relative Humidity	--	
	Wind Speed	--	
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	7 sec.	5%
	Temperature entering & leaving collectors	7 sec.	1%
	Storage		
	Flow rate inputs to storage	--	
	Temperature entering & leaving storage		
	Temperature readings in storage(1 or more)	20 min.	1%
	Auxiliary energy supplied to storage	--	
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	7 sec.	5%
	Temperature entering & leaving subsystems	7 sec.	1%
	Auxiliary energy supplied to subsystems	7 sec.	2%
BUILDING SYSTEM	Average DB inside temperature	7 sec.	1%
	Infiltration load	--	
	Auxiliary energy	duty time	2%
	Operating energy	duty time	2%
	Total building energy load	7 sec. SH*)	2%
	Internal energy gains	--	
	Solar gains	--	
	Solar as a % of total load	7 sec. SH*)	2%
	Thermal capacity of building		

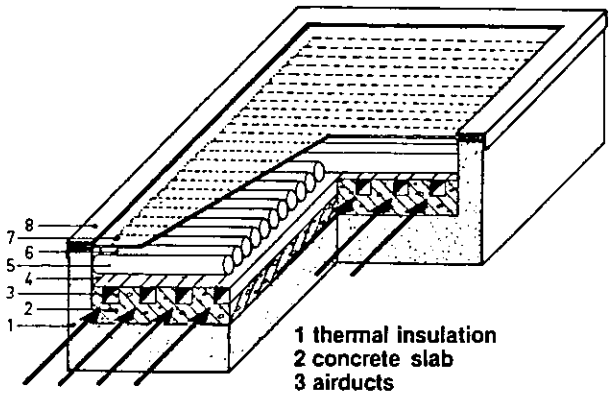
*SH = Space heating

ILLUSTRATION

1. exhaust ventilator(ventilation air and fuel gasses
2. ventilator for outside air
3. auxiliary ventilator collector circuit
4. heat recuperation system
5. air boiler
6. air collector
7. gas airheater (re-heater)
8. gas boiler (re-heater)
9. supply grids under ceiling
10. return grids above floor
11. return channels (dwelling)
12. supply channels (dwelling)
13. exhausting ventilation air
14. supply channel collector (cooled air)
15. return channel collector (heated air)
16. movable heat reflecting window screens

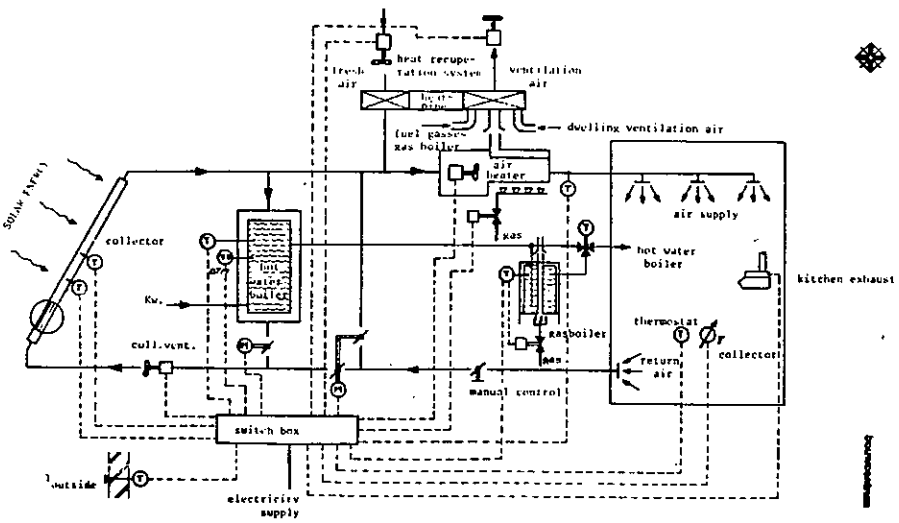


SOLAR HOUSE ZUNDERT



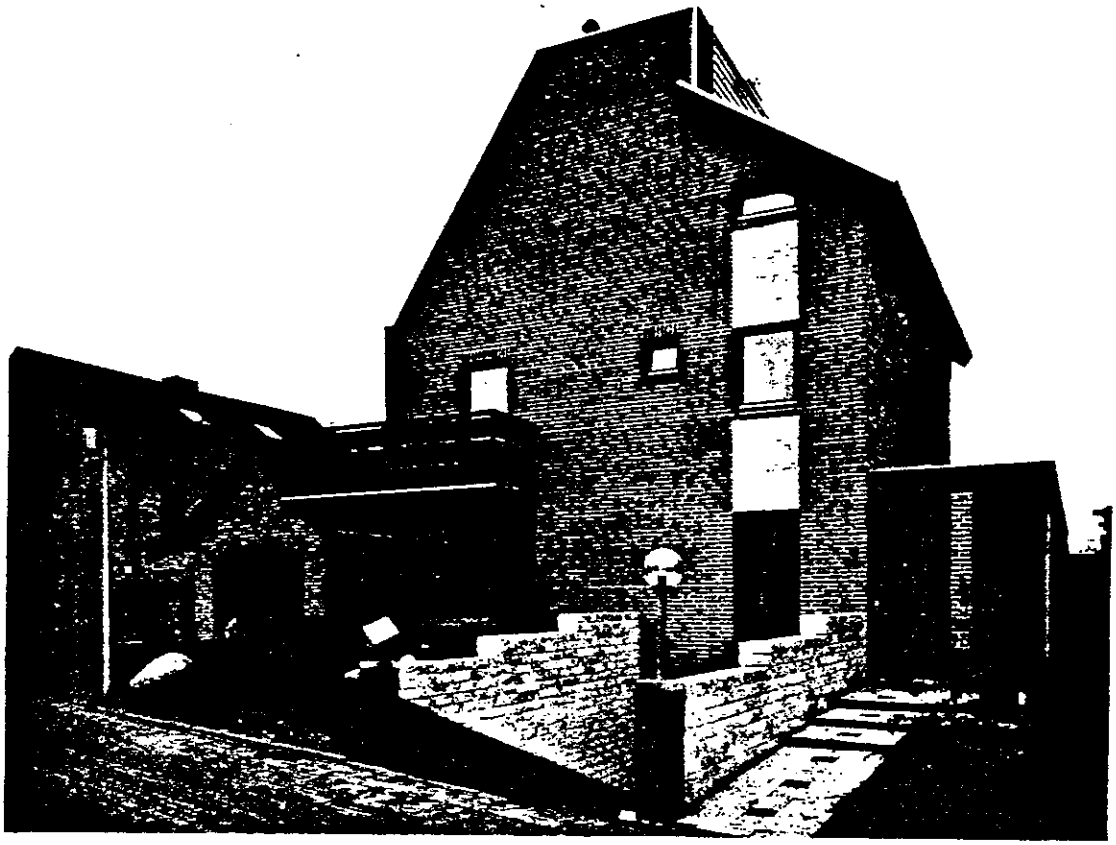
1 thermal insulation
2 concrete slab
3 airducts
4 cavity
5 glass vacuum tubes with spectrally selective coating
6 cavity
7 single glazing
8 frame

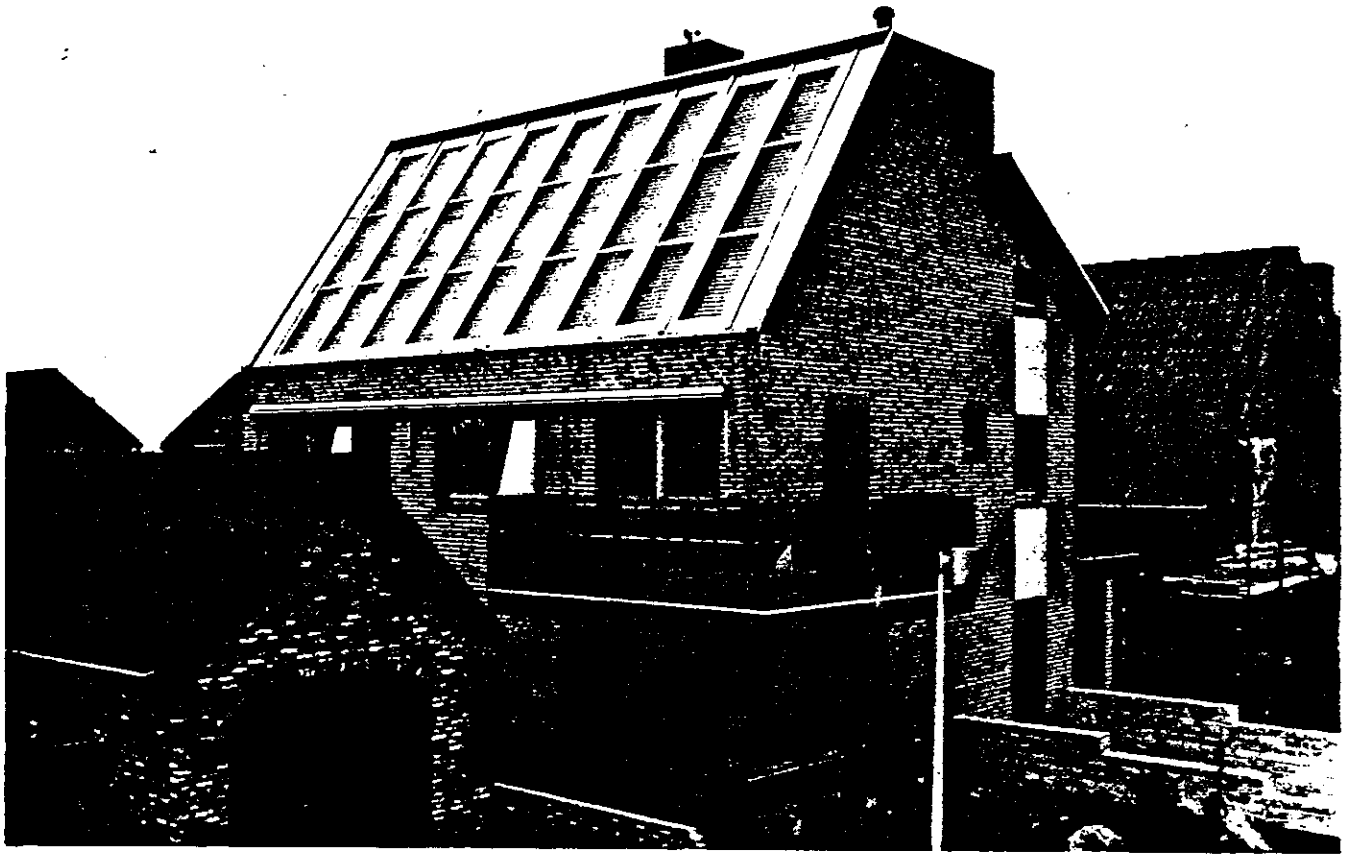
AIR COLLECTOR WITH INTEGRATED HEAT-STORAGE



CONTROL SYSTEM OF THE SOLAR HEATING INSTALLATION IN ZUNDERT

ILLUSTRATION





SWEDEN

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Low Energy House in Bollebygd

Address: Bollebygd
Göteborg
Sweden

MAIN PARTICIPANTS

	1	2	3
Name	Prof. Hans Nordenström Matti Mikkonen, architect	Egil Öfverholm	T. Esbensen
Address	Chalmers University of Technology Goteborg, Sweden	Swedish Council for Building Research Stockholm, Sweden	E.K. Energirådgivning (Energy consultancy) Copenhagen
Phone	031/810 100	08 - 54 06 40	02 - 87 72 76
Responsibility	Project coordinator Architect and owner	Financial support	Evaluation and reporting

This format was filled in by Poul E. Kristensen Technical Univ. of Denmark and (3)

PROJECT DESCRIPTION

CLIMATE

Latitude 58° Longitude 12° E Altitude ~ 0 m DD 3120 Base Temp. 17

Sunshine Hours July 270 January 52 Annual 1894

Source of data Roger Taesler: "Klimatdata för Sverige", 1972 (Torslanda Airport, Göteborg 1952-68)

Urban ____ Suburban X Rural ____

BUILDING

Floor area 140 m² No. Occupants 4

Design Temperature internal w 20 s ____ °

external w -15 s ____ °

Mass type ____ location ____

South Glazing type 4 pane glazing

area(south glass) 18 m² % of total glass 75%

night insulation none shaded yes

Heated Volume ____ Ventilation Rate .4 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) ____

Collector type single glazed, non insulated area(net) 6 m² + 22 m² } 28 m²

orientation south tilt 70°

Storage type steel tanks, 2.8 + 0.2 m³ capacity 12.6 MJ/K (3 m³ water)

Auxiliary System type wood-burner furnace and direct electricity fuel type wood + electr. fuel cost ? approx. .23 Skr/kWh

PROJECT SCHEDULE

MILESTONES \ DATE						
Construction completion	May 78					
Monitoring period		Jan. 79	April 81			
Final reports				Oct. 81		

Report availability — Title (available from): "A Low Energy House in Sweden ..." by T.V. Esbensen, Proceedings from 2. Int. Sonnenforum, Hamburg 1978

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: 60,000 Dcrs.

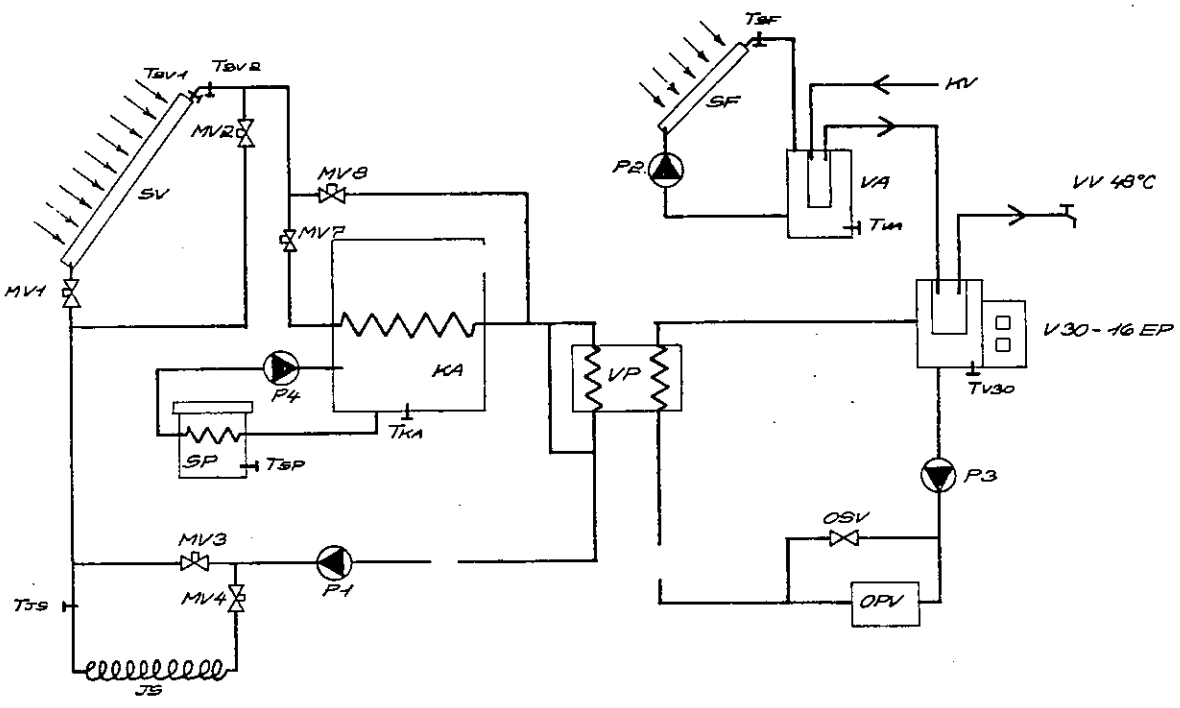
Description of data recording method: manual reading weekly (energy) + chart recorder (temperatures)

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	-	
	Outdoor Temperature	Ch	
	Incident radiation on horizontal surface	-	
	Incident radiation in plane of collector	-	
	Relative Humidity	Ch	
	Wind Speed	-	
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	-	
	Temperature entering & leaving collectors	-	
	Storage		
	Flow rate inputs to storage		
	Temperature entering & leaving storage	w	± 5-10%
	Temperature readings in storage(1 or more)	-	
	Auxiliary energy supplied to storage	-	
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems		
	Temperature entering & leaving subsystems	w	± 2%
	Auxiliary energy supplied to subsystems	w	
BUILDING SYSTEM	Average DB inside temperature	Ch	
	Infiltration load	-	
	Auxiliary energy	w	
	Operating energy	w	
	Total building energy load	-	
	Internal energy gains	-	
	Solar gains	-	
	Solar as a % of total load	-	
	Thermal capacity of building	-	

Ch = chart recording w = weekly reading of meter

ILLUSTRATION



System Diagram

SV : low temperature collector (22 m^2)
KA : accumulator (3 m^3)
JS : ground coils
KV : domestic cold water

SF : high temperature collector (6 m^2)
VA : accumulator (0.2 m^3)
VP : heat pump
SP : waste water recovery
VV : domestic hot water
OPV : space heating system

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

SUN SEC: Serieanpasset Solhus

Address

Rågvägen 10
Fjärås (36 km south of Göteborg)
Sweden

MAIN PARTICIPANTS

	1	2	3
Name / **Address**	G. Nordseldt Research Fellow Chalmers University of Technology Göteborg, Sweden	Egil Ofverholm Swedish Council for Building Research Stockholm, Sweden	T. Esbensen E.K. Energirådgivning (Energy consultancy) Copenhagen
Phone	031/810 100	08-54 06 40	02-87 72 76
Responsibility	Owner Project coordinator	Financial support	Evaluation and reporting

PROJECT DESCRIPTION

This format was filled in by Poul E. Kristensen Technical Univ. of Denmark and (3)

CLIMATE

Latitude 57° 24'N Longitude 12° 10'E Altitude ~ 0 DD 3120 Base Temp. 17

Sunshine Hours July 270 January 52 Annual 1894

Source of data Roger Taesler: Klimatdat för Sverige (Torslanda airport, Göteborg 1952-68)

Urban ____ Suburban X Rural ____

BUILDING

Floor area ~ 160 m^2 *) No. Occupants 3

Design Temperature internal w 20 °C s ____ °

external w -15 °C s ____ °

Mass type ____ location ____

South Glazing type triple glazing

area(south glass) 15 m^2 % of total glass 90

night insulation no shaded yes

Heated Volume ~ 380 m^3 Ventilation Rate ____ a.c.h.

*) heated area, within ext. walls

SOLAR SYSTEM

System energy use(eg. heating) 10.800 kWh

Collector type AGA DFP air collector area(net) 32.4 m^2

orientation 177° from N tilt 70°

Storage type two steel tanks capacity 12.6 MJ/K (3 m^3 water)

Auxiliary System type heat pump and ~~direct electricity~~ fuel type el fuel cost approx. .23 Skr/kWh

PROJECT SCHEDULE

MILESTONES \ DATE						
Construction completion	Sept. 79					
Monitoring period		April 80	Oct. 81			
Final reports				March 82		

Report availability — Title (available from): SUN SEC: Serieanpasset Solhus; G. Nordfeldt et al.; Byggforskningsrådet, Stockholm

INSTRUMENTATION (existing or anticipated)

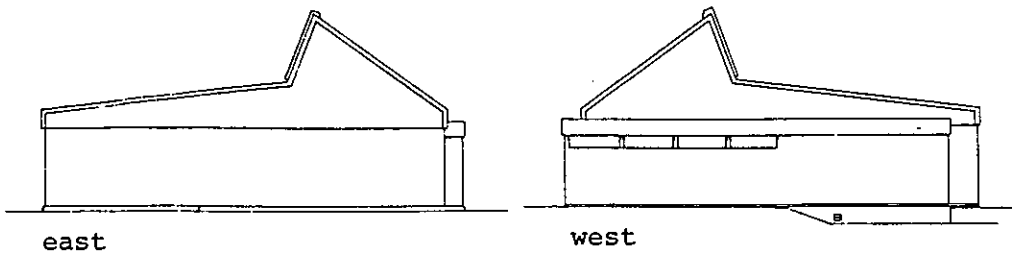
Approximate cost of instrumentation package: _____

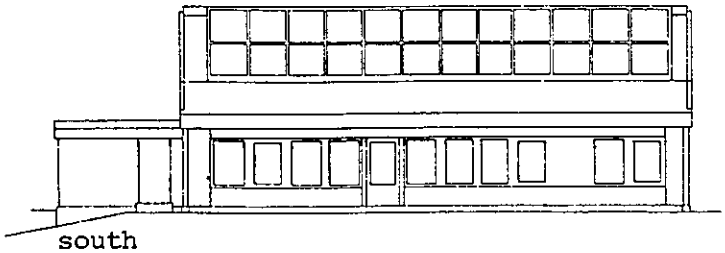
Description of data recording method: mag. tape casettes

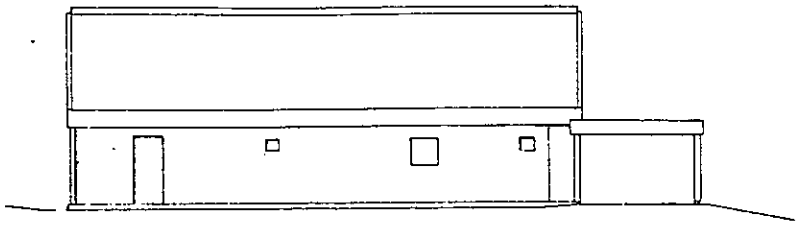
DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	-	-
	Outdoor Temperature	1 hour	± .5 °C
	Incident radiation on horizontal surface	10 min.	± 5 %
	Incident radiation in plane of collector	- " -	- " -
	Relative Humidity	-	-
	Wind Speed	10 min.	± .6 m/s
SOLAR SYSTEM		I = integrated value	
	Collectors		
	Flow rate entering collectors	1 hour I	± 5%
	Temperature entering & leaving collectors	-	-
	Storage		
	Flow rate inputs to storage		
	Temperature entering & leaving storage	1 hour I	± 5%
	Temperature readings in storage(1 or more)	1 hour	± .5 °C
	Auxiliary energy supplied to storage	-	-
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems		
	Temperature entering & leaving subsystems	1 hour I	± 5%
	Auxiliary energy supplied to subsystems	1 hour I	
BUILDING SYSTEM		I = integrated value	
	Average DB inside temperature	1 hour	± .5 °C
	Infiltration load	-	-
	Auxiliary energy	-	-
	Operating energy	1 hour	
	Total building energy load	(1 hour)	-
	Internal energy gains	1 hour	
	Solar gains	1 hour I	± 5%
	Solar as a % of total load	-	-
	Thermal capacity of building	-	-

ILLUSTRATION

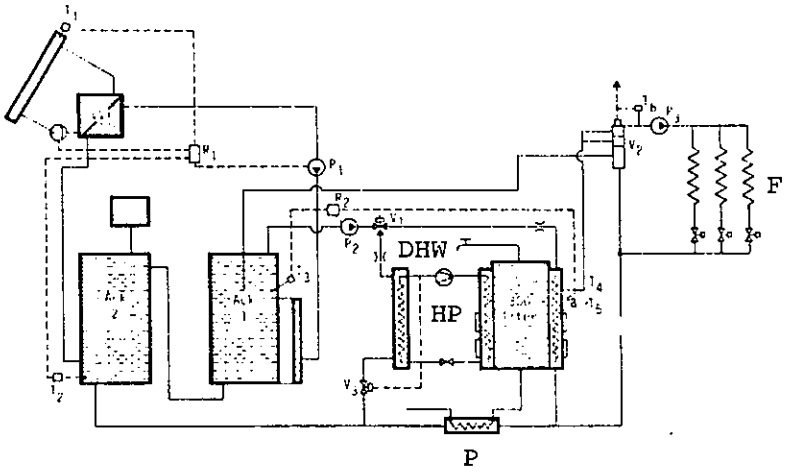






The SUN SEC house

Front elevations



System Diagram

VVX: air/water heat exchanger
Ack: heat storage tank
DHW: domestic hot water
HP: heat pump
P: domestic hot water preheater
F: floor heating

SWITZERLAND

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

PASSIVE SOLAR HOUSE

Address: " BEGNINS "

(Direct gains)

BEGNINS (Switzerland)

MAIN PARTICIPANTS

	1	2	3
Name	STUBY F. & G.	PERRIN G.-R.	FAIST A.
Address	Les Fontanettes 1268 BEGNINS	Solar Group EPF-L Department of Physics P.O.Box 1024 CH - 1001 Lausanne	Solar Group EPF-L Department of Physics P.O.Box 1024 CH - 1001 Lausanne
Phone	(022) 66.26.18	(021) 47.34.31	(021) 47.34.31
Responsibility	Architect / Owner	Responsible researcher	Professor

PROJECT DESCRIPTION

CLIMATE

Latitude 46.5° Longitude 6.5° Altitude 615 m DD 3240°K Base Temp. 20/12

Sunshine Hours July 272 January 70 Annual 1950

Source of data Institut Suisse de Météorologie (Average data)

Urban ____ Suburban ____ Rural X

BUILDING

Floor area 210 m² No. Occupants 2 - 3

Design Temperature internal w 18 s 24 °C

external w - 10 s 30 °C

Mass type Concrete location Floor + Chimney

South Glazing type Double-pane (thermopane)

area(south glass) 28 m² % of total glass 40 %

night insulation U value night 1.6 W/m²K shaded ____

Heated Volume 742.5 m³ Ventilation Rate 0.3 - 0.5 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Space heating (Passive direct gain)

Collector type windows double pane with night insulation area(net) 28.0 m²

orientation ~~(South-East) 165°~~ tilt 90 °C

7 (kWh/°C)

Storage type Concrete (floor+Chimney) capacity 10 m³ (concrete)

Auxiliary System type Electric resistance fuel type Electricity fuel cost Sfr. 0.1/kWh

PROJECT SCHEDULE

MILESTONES \ DATE		1977	1978	1979	1980	
Construction completion		▨				
Monitoring period				▨	▨	
Final reports					●	

Report availability — Title (available from)

Passive Solar House "Begnins" Task I(IEA) (english)
~~Passive Solar House "Begnins" Task I(IEA) (french)~~
Solar Group EPF-L, Dept. of Physics, G.-R.PERRIN
P.O.Box 1024 / CH-1001 Lausanne

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: US$ 20'000.-

Description of data recording method: 64 channels analogic (with integrator) 8 pulse counter, A-D connector & scanner magnetic cartridge recorder

DATA RECORDED

METEOROLOICAL

	Frequency of data recording	Accuracy of instrument
Degree Days	0.5 hour	1.0 °C
Outdoor Temperature	0.5 hour	0.5 °C
Incident radiation on horizontal surface	0.5 hour *	5 % (Kipp-Zonen)
Incident radiation in plane of collector	0.5 hour *	5 % (Kipp-Zonen)
Relative Humidity	0.5 hour	3 %
Wind Speed	0.5 hour *	2 % (max.)

* mesure every 30 seconds, integration every 0.5 hour.

SOLAR SYSTEM

NO ACTIVE SYSTEM

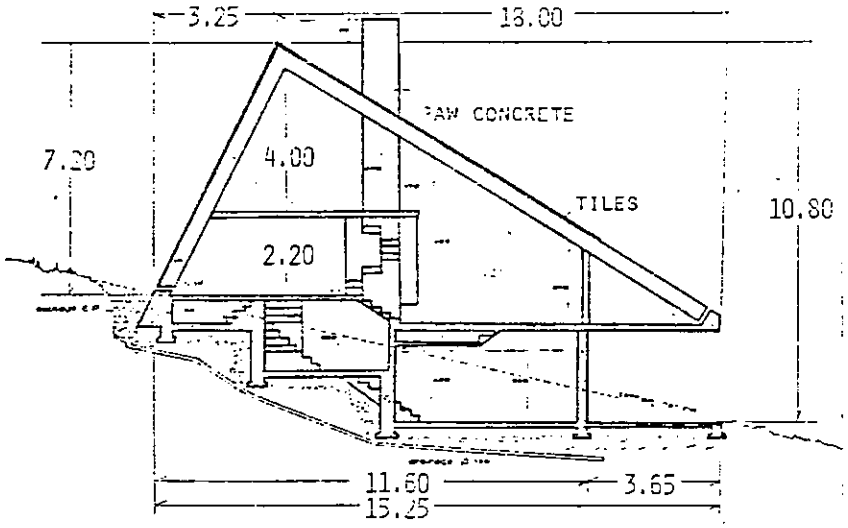
Collectors		
Flow rate entering collectors		
Temperature entering & leaving collectors		
Storage		
Flow rate inputs to storage		
Temperature entering & leaving storage		
Temperature readings in storage(1 or more)		
Auxiliary energy supplied to storage		
Space heat,Space cooling,Hot water Subsystems		
Flow rates entering subsystems		
Temperature entering & leaving subsystems		
Auxiliary energy supplied to subsystems		

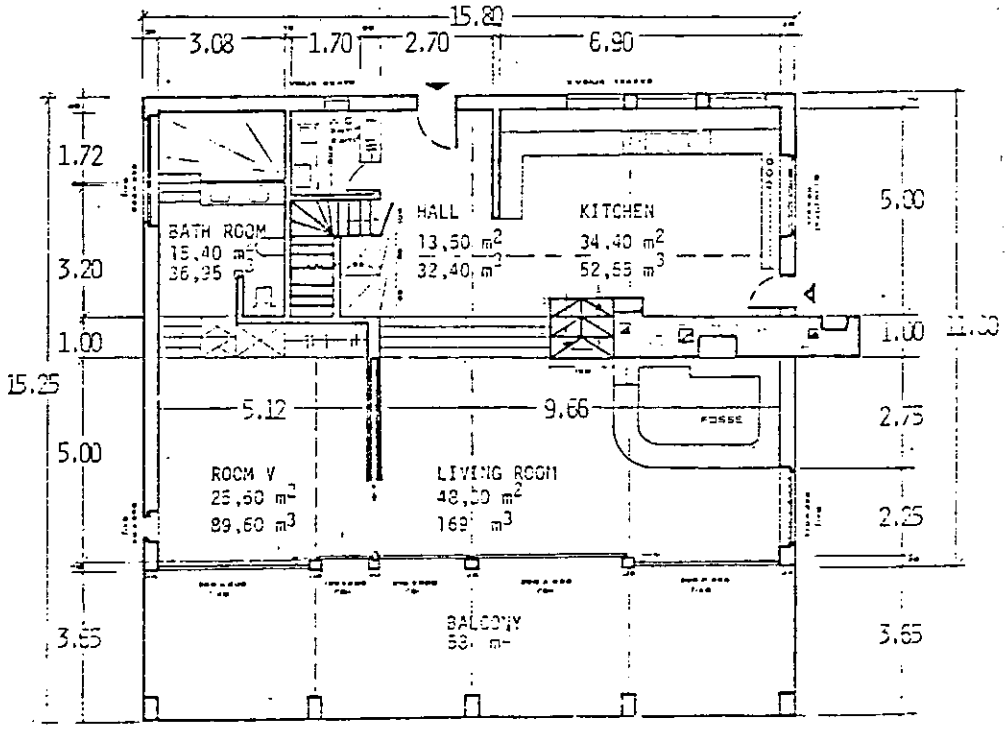
BUILDING SYSTEM

Average DB inside temperature	0.5 h.	0.5 °C
Infiltration load	0.5 h. **	
Auxiliary energy	0.5 h. *	3 %
Operating energy	0.5 h. *	3 %
Total building energy load	0.5 h. *	
Internal energy gains	0.5 h. *	
Solar gains	0.5 h. *	
Solar as a % of total load	0.5 h. *	
Thermal capacity of building	0.5 h.	

** Aperture time of doors and windows are integrated.

ILLUSTRATION





IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

PASSIVE & ACTIVE Solar House
"Les Geneveys / Coffranes"
(Greenhouse + air & water collectors)
Switzerland

MAIN PARTICIPANTS

	1	2	3
Name	A.GILLABERT	PERRIN G.R.	FAIST A.
Address	rte des Carabiniers 2206 Les Geneveys/Coffrane Switzerland	Solar group EPF-L Dept. Physics P.O.Box 1024 CH - 1001 Lausanne	Solar Group EPF-L Dept. Physics P.O.Box 1024 CH - 1001 Lausanne
Phone		(021) 47'34'31	(021) 47'34'31
Responsibility	Owners	Responsible researcher	Professor

PROJECT DESCRIPTION

CLIMATE

Latitude 47.0° Longitude 6.9° Altitude 820 m DD 4234° C Base Temp. 20/12

Sunshine Hours July 237.3 January 50.1 Annual 1450

Source of data Inst. Suisse de Météorologie (average data)

Urban ____ Suburban ____ Rural X

BUILDING

Floor area 136.8 m² No. Occupants 3 - 4

Design Temperature internal w 18 s 24 °C

external w - 10 s 30 °C

Mass type concrete location Floor + walls(ext. insul.)

South Glazing type double pane (thermopane)

area(south glass) 21.3 m² % of total glass 67 %

night insulation U value night 1.6(W/m²k) shaded ____

Heated Volume 319 m³ Ventilation Rate 0.3 - 0.5 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Space heating + DHW (passive + active system)

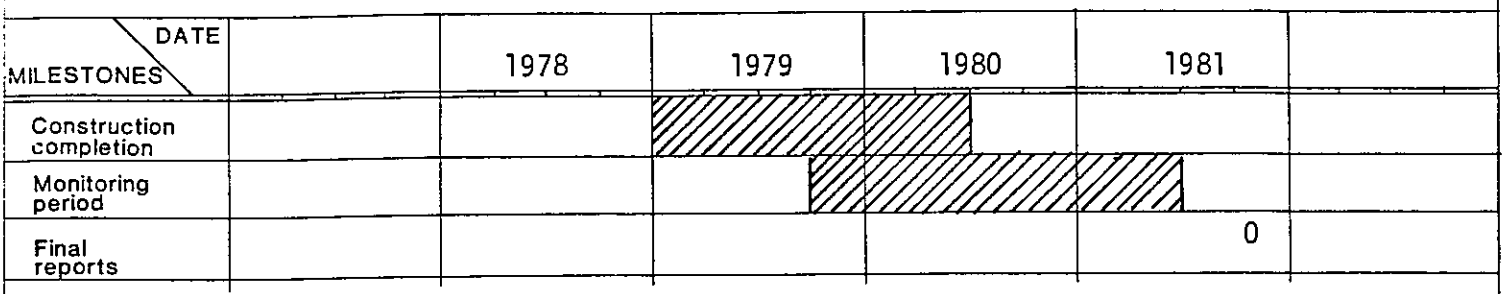
Collector type Falt palte (double glazed (water) ~~single glazed (air)~~) area(net) 14 m² / 23 m²

orientation ~~225 0 135°~~ tilt 90° / 80°

Storage type water (vertical tank) capacity 3.7 m³

Auxiliary System type wood-burner fuel type wood fuel cost 0.05 sfr/kWh

PROJECT SCHEDULE



Report availability — Title

(available from) Solar group EPF-L dept.Physics, G.-R.Perrin
P.O.Box 1024 / CH-1001 Lausanne - Sitzerland

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package 20'000.- US$

Description of data recording method 64 channels analogic (with integrator)12 pulse-counters - A-D convector & Scanner magnetic cartridge recorder

DATA RECORDED

METEOROLOICAL

	Frequency of data recording	Accuracy of instrument
Degree Days	0.5 hour	1.0 °C
Outdoor Temperature	0.5 hour	0.5 °C
Incident radiation on horizontal surface	0.5 hour *	5% (kipp-Zonen)
Incident radiation in plane of collector	0.5 hour *	5% (kipp-Zonen)
Relative Humidity	0.5	3%
Wind Speed	0.5 hour *	2% (max.)

* mesure every 30 seconds, integration every 0.5 hour

SOLAR SYSTEM

Collectors		
Flow rate entering collectors	0.5 hour ***	3%
Temperature entering & leaving collectors	0.5 hour ***	0.2 °C
Storage		
Flow rate inputs to storage	0.5 hour ***	3%
Temperature entering & leaving storage	0.5 hour	0.2 °C
Temperature readings in storage(1 or more)	0.5 hour	0.2 °C
Auxiliary energy supplied to storage	0.5 hour	
Space heat,Space cooling,Hot water Subsystems		
Flow rates entering subsystems	0.5 hour ***	3%
Temperature entering & leaving subsystems	0.5 hour	0.2 °C
Auxiliary energy supplied to subsystems		

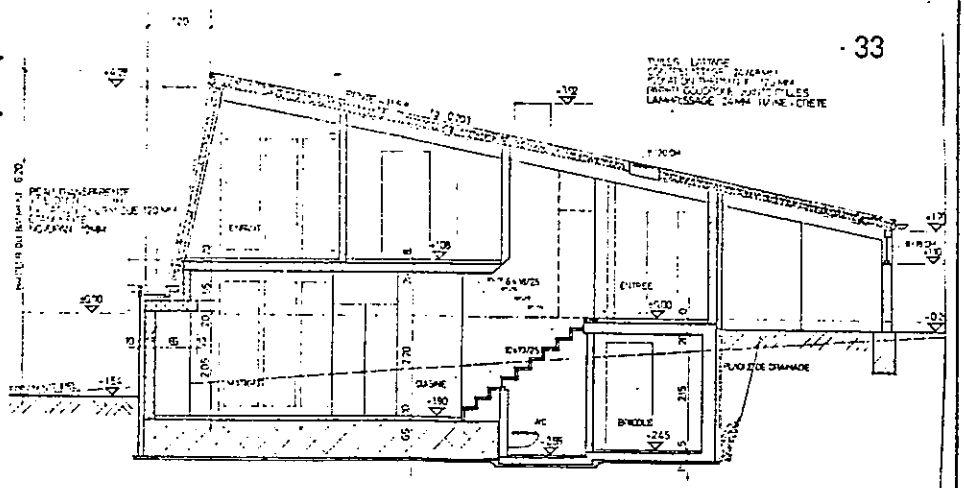
*** Energy is counted doing the product $\dot{m} \cdot C_p \cdot \Delta T$ every pulse of the flowmeter

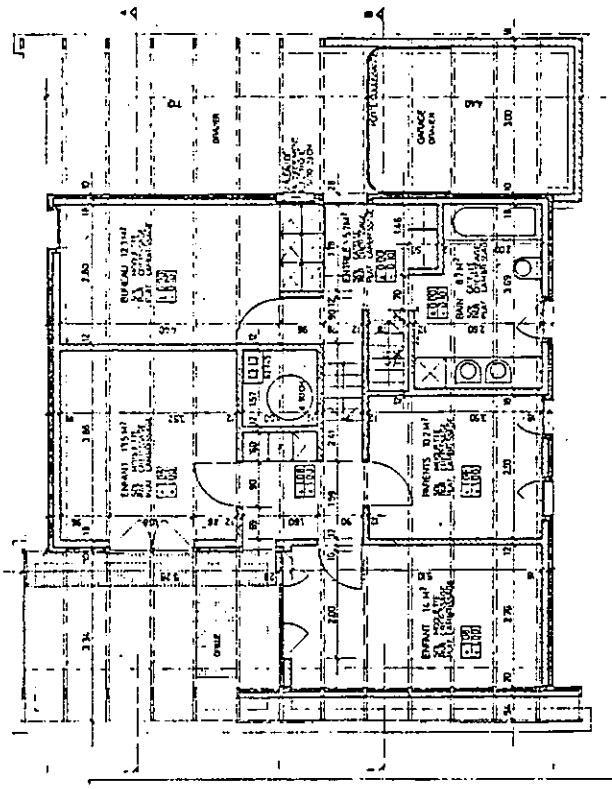
BUILDING SYSTEM

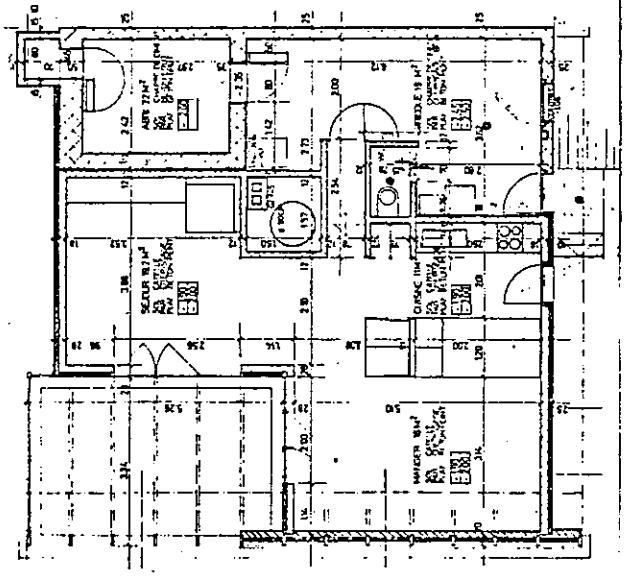
Average DB inside temperature	0.5 hour	0.5 °C
Infiltration load	0.5 hour **	
Auxiliary energy	0.5 hour *	3%
Operating energy	0.5 hour *	3%
Total building energy load	0.5 hour *	
Internal energy gains	0.5 hour *	
Solar gains	0.5 hour *	
Solar as a % of total load	0.5 hour	
Thermal capacity of building		

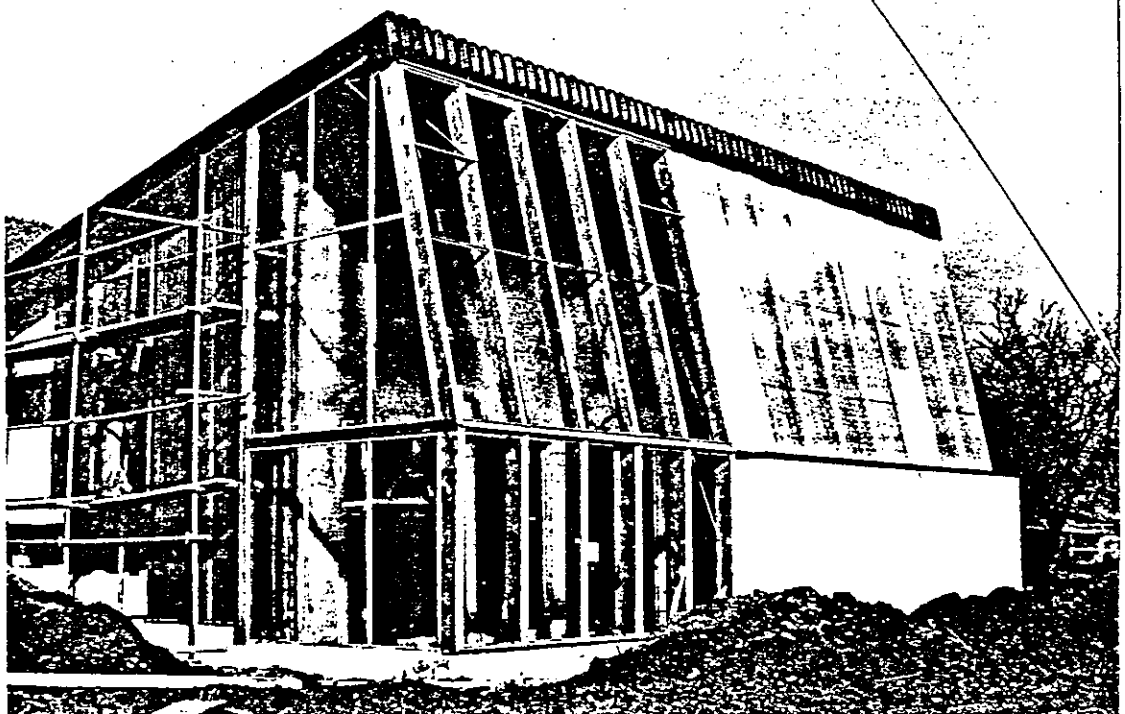
** Aperture time of doors and windows are integrated

ILLUSTRATION









IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Performance of real active heating systems

Address

MAIN PARTICIPANTS

	1	2	3
Name	A.DELFOSSE	JP.THERRE	
Address	Institut de thermique appliquée Ecole Polytechnique Fédérale-Halle de Mécanique 1015-Lausanne	Institut de thermique appliquée Ecole Polytechnique Fédérale-Halle de Mecanique 1015-Lausanne	
Phone	(021)473525	(021)473525	
Responsibility	Research scientist	Research scientist	

PROJECT DESCRIPTION

CLIMATE

Latitude 46°50' Longitude ~6° Altitude 495m DD 3820 Base Temp. 18°C

Sunshine Hours July ____ January ____ Annual 1810

Source of data Centre Meteorologique de Payerne

Urban ____ Suburban * ____ Rural ____

BUILDING

Floor area 211 m² No. Occupants 4-5

Design Temperature internal w 22 s 18 ° C

external w -20 s 30 ° C

Mass type Villa pertaining to family location Payerne(Suisse)

South Glazing type double glass

area(south glass) / % of total glass /

night insulation / shaded /

Heated Volume 613m³ Ventilation Rate ____ a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Heating+D.H.W

Collector type Built-in,flat area(net) 20 m²

orientation South-West 219° tilt 43°

Storage type Water + Beton capacity 14800Litres

Auxiliary System type Boiler + Wood chimney (35kW) fuel type Domestic fuel fuel cost 0.6SF/L

PROJECT SCHEDULE

MILESTONES \ DATE	1976	Jan 1980	1980	1981	1 trim1982	
Construction completion	House	Instrumen-tation				
Monitoring period			*	*		
Final reports					*	

Report availability Title _____

(available from) _____

_____

INSTRUMENTATION (existing or anticipated)

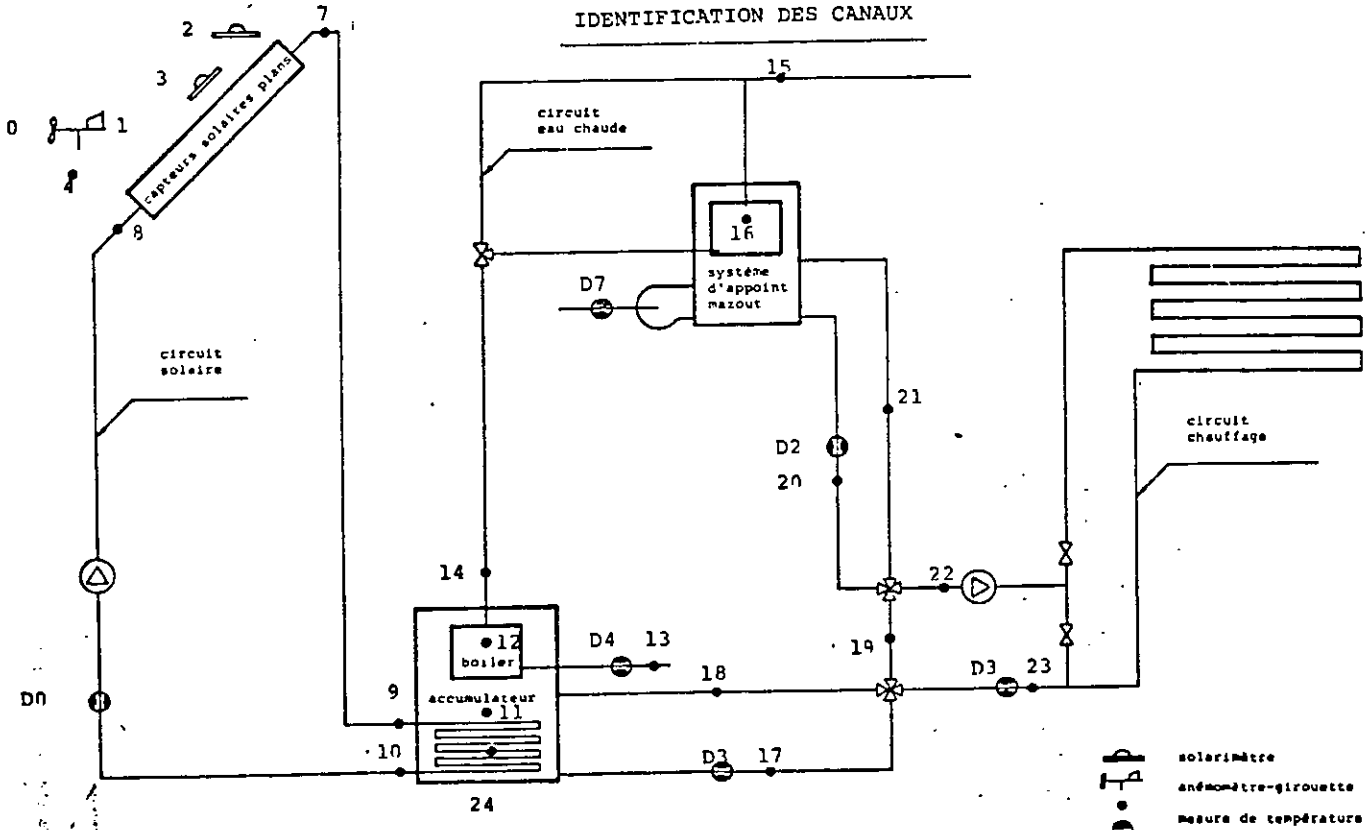
Approximate cost of instrumentation package _____

Description of data recording method 30 seconds intervalmeasurements recording of integrated values at 15 minutes intervals on cassette-tap

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	15 minutes	0.2°C.time
	Outdoor Temperature	"	0.2°C
	Incident radiation on horizontal surface	"	4 %
	Incident radiation in plane of collector	"	4 %
	Relative Humidity	"	
	Wind Speed	"	2 % f.s.
SOLAR SYSTEM	Collectors	"	
	Flow rate entering collectors	"	1 %
	Temperature entering & leaving collectors	"	0.1°C
	Storage		
	Flow rate inputs to storage	"	1%
	Temperature entering & leaving storage	"	0.1°C
	Temperature readings in storage(1 or more)	"	0.1°C
	Auxiliary energy supplied to storage	"	est.5 %
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	"	1 %
	Temperature entering & leaving subsystems	"	0.1°C
	Auxiliary energy supplied to subsystems	"	est.5 %
BUILDING SYSTEM	Average DB inside temperature	"	0.2°C
	Infiltration load	not meas.	
	Auxiliary energy	15 minutes	
	Operating energy	"	
	Total building energy load	"	
	Internal energy gains	not meas.	
	Solar gains	15 minutes	
	Solar as a % of total load	"	
	Thermal capacity of building	not meas.	

ILLUSTRATION



b) SCHEMA DE L'INSTALLATION A.I.E. A PAYERNE AVEC POINTS DE MESURE

Propriétaire: M. SCHNEITER

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Trombe Wall instrumentation

Address: Chemin des Côtes
1020 Renens - Switzerland
Mr. Martin WENGER

MAIN PARTICIPANTS

	1	2	3
Name	WENGER M.	MOREL N.	PERRIN G.-R.
Address	Chemin des Côtes 1020 Renens Switzerland	Solar Groupe EPFL Dpt. of Physics PO Box 1024 1001 Lausanne - Switz.	Solar Group EPFL Dept. of Physics P.O.Box 1024 1001 Lausanne - Switz.
Phone		(021) 47'34'27	(021) 47'34'31
Responsibility	Owner	Responsible researcher	Responsible researcher

PROJECT DESCRIPTION

CLIMATE

Latitude 46.5°N Longitude _____ Altitude 450 m DD 3250 Base Temp. 20° C

Sunshine Hours July 272 January 69 Annual 1953

Source of data Solar Group EPFL

Urban _____ Suburban X Rural _____

BUILDING

Floor area 220 m² No. Occupants 3 - 4

Design Temperature internal w 18 s 24 °C

external w -10 s +30 °C

Mass type Concrete location Floors + Walls

South Glazing type Double pane (thermopane)

area(south glass) 8 m² (16m² greenhouse) % of total glass 30% (56% ind.grch.)

night insulation -- shaded _____

Heated Volume ≈ 700 m² Ventilation Rate 0.3 - 0.5 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Space heating

Collector type TROMB - WALL + GREENHOUSE area(net) 14 m²

orientation SOUTH (210°) tilt 90° (vertical)

Storage type Concrete capacity 1764 Wh/°K

Auxiliary System type gaz heater fuel type gaz fuel cost Sfr. 0.05/kWh

PROJECT SCHEDULE

MILESTONES \ DATE	1980	1981	1982			
Construction completion						
Monitoring period						
Final reports			●			

Report availability — Title _____

(available from) _____

_____

INSTRUMENTATION (existing or anticipated)

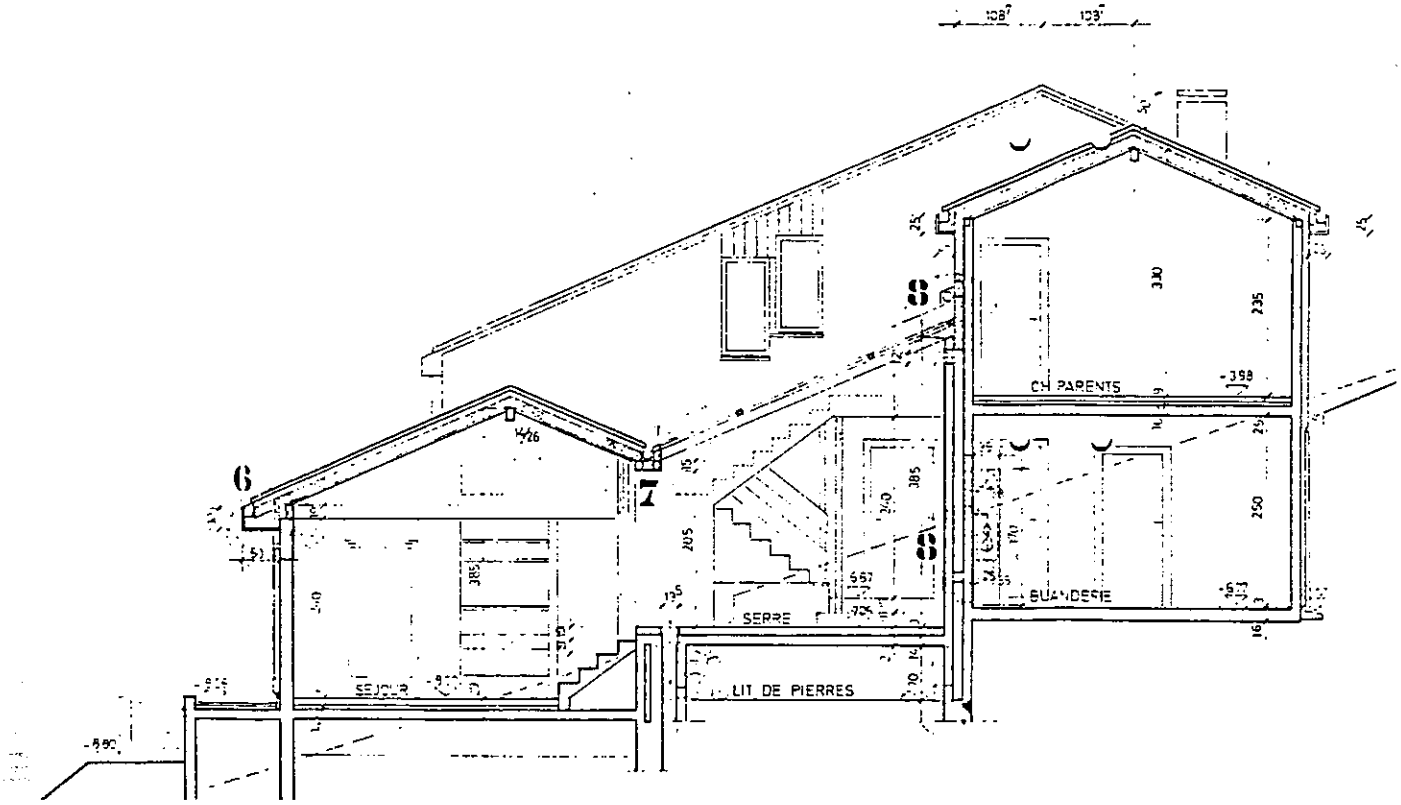
Approximate cost of instrumentation package: Sfr. 60'000.-

Description of data recording method: Hewlett-Packard data acquisition system (HP 9835A + scanner + digital voltmeter + pulse counter), recording on HP-cassettes

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	-	-
	Outdoor Temperature	30 min.	± 0.2 °K
	Incident radiation on horizontal surface	-	-
	Incident radiation in plane of collector	30 sec/30min.	± 50 W/m²
	Relative Humidity	-	-
	Wind Speed	30 min.	± 1 m/s
		when 2 numbers are specified, the first one is t measurement rate, and the second one the integra ted measurement recording rate.	
SOLAR SYSTEM	(Collectors)		
	Flow rate entering collectors	30 sec/30 min.	± 0.1 m/s
	Temperature entering & leaving collectors	30 min.	± 0.2 °K
	Storage		
	Flow rate inputs to storage		
	Temperature entering & leaving storage		
	Temperature readings in storage(1 or more)		
	Auxiliary energy supplied to storage		
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems		
	Temperature entering & leaving subsystems		
	Auxiliary energy supplied to subsystems		
BUILDING SYSTEM	Average DB inside temperature	30 sec/30 min.	± 0.2 °K
	Infiltration load		
	Auxiliary energy		
	Operating energy		
	Total building energy load		
	Internal energy gains		
	Solar gains		
	Solar as a % of total load		
	Thermal capacity of building		

ILLUSTRATION



IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

SONNENENERGIEHAUS ZUG

Address: Stiftung Sonnenenergiehaus Zug
c/o Dr. A. Stebler Schönbühl 6
CH-6300 ZUG

MAIN PARTICIPANTS

	1	2	3
Name Address	Dr. A. Stebler Schönbühl 6 CH-6300 ZUG	E. Ruosch c/o Landis & Gyr Zug AG CH-6301 ZUG	
Phone	042 24 20 40	042 24 31 44	
Responsibility	General Project	Instrumentation	

PROJECT DESCRIPTION

CLIMATE

Latitude 47.2 N Longitude 8.5 E Altitude 448 m DD 4115 Base Temp. 5 °C

Sunshine Hours July 6.5 January 0.8 Annual 3.9

Source of data S.M.A. Zürich Krähbühlstrasse 58

Urban ____ Suburban x Rural ____

mean outside Temp. during heating period

BUILDING

Floor area 440 m² No. Occupants 19

Design Temperature internal w 22 s — °C

external w -10 s — °C

Mass type Brick location plain

South Glazing type double glazing

area(south glass) 24 m² % of total glass 41.5

night insulation shutters shaded 0-100 %

Heated Volume 1100 m³ Ventilation Rate 0.4 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Heating and warm water

Collector type low temperature (Energy-roof) area(net) 113 m²

orientation 40 m² NN / 73 m² SE tilt 27 °

Storage type Hot water capacity 1.2 m³

Auxiliary System type el. heat pump bivalent with oil burner fuel type Electric. Oil fuel cost Fr.0,14/kWh Fr.0,5/l

PROJECT SCHEDULE

MILESTONES \ DATE	Oct. 78	March 80	Dec. 82			
Construction completion	Insulation	Energy Roof	System-Optimization			
Monitoring period	since Oct. 78	since March 80	till Dec. 82			
Final reports	Nov. 79	Dec. 81	July 83			

Report availability — Title (available from): Projekt Sonnenenergiehaus Zug; Bericht No 1 und No 2; Stiftung Sonnenenergiehaus Zug

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: 40 000.- Fr.

Description of data recording method: Recorder (12-Points) + Counters

DATA RECORDED

	Frequency of data recording	Accuracy of instrument
METEOROLOICAL		
Degree Days	—	—
Outdoor Temperature	cont.	3 %
Incident radiation on horizontal surface	—	—
Incident radiation in plane of collector	—	—
Relative Humidity	—	—
Wind Speed	—	—
SOLAR SYSTEM		
Collectors		
Flow rate entering collectors	—	—
Temperature entering & leaving collectors	cont.	3 %
Storage		
Flow rate inputs to storage	—	—
Temperature entering & leaving storage	cont.	3 %
Temperature readings in storage(1 or more)	cont.	3 %
Auxiliary energy supplied to storage	cont.	3 %
Space heat, Space cooling, Hot water Subsystems		
Flow rates entering subsystems	cont.	3 %
Temperature entering & leaving subsystems		
Auxiliary energy supplied to subsystems	cont.	1 %
BUILDING SYSTEM		
Average DB inside temperature	cont.	5 %
Infiltration load	sporadically	20 %
Auxiliary energy	cont.	1 %
Operating energy	cont.	1 %
Total building energy load	cont.	3 %
Internal energy gains	—	—
Solar gains	mean coefficient of performance ~2	10 %
Solar as a % of total load		
Thermal capacity of building	—	—

ILLUSTRATION

See enclosures

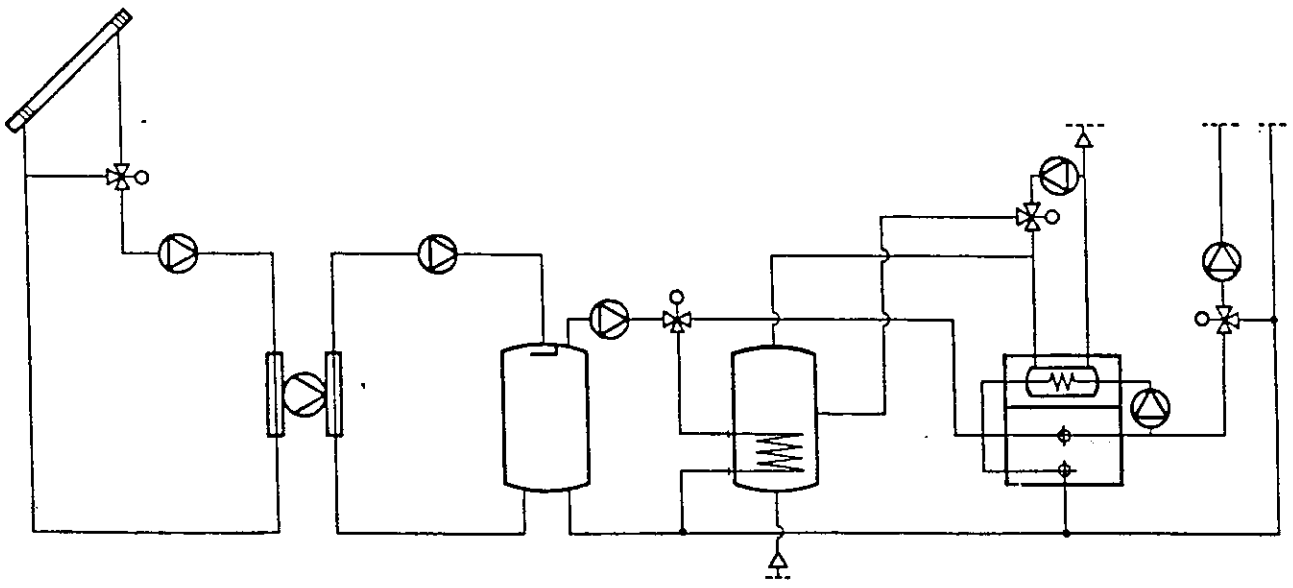
. Photo showing energy-roof and general situation (identical not renewed neighbouring buildings)

. "hydraulic" system

. report 13.9.78 - 30.6.79

PROJEKT SONNENENERGIEHAUS ZUG

HYDRAULISCHES PRINZIPSCHEMA



NT-KOLLEKTOREN (113.0 m²) | WÄRMEPUMPE (10PS 2STUFIG) | ARBEITSSPEICHER 600LT | BOILER 400LT NEU | HEIZKESSEL BEST. UND BOILER MIT BOILERLADEPUMPE UND WW ZIRKULATIONSPUMPE

UNITED KINGDOM

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Linford

Address

Milton Keynes

Bucks

England

MAIN PARTICIPANTS

	1	2	3
Name	Alan Morton	Bob Everett	John Dogart
Address	Energy Research Group Open University Milton Keynes	Energy Research Group Open University Milton Keynes	Milton Keynes Development Corporation Cofferidge Close Stony Stratford Milton Keynes
Phone	0908 653335	0908 653335	0908 565454
Responsibility	Project Officer	Research Fellow	Project Supervisor

PROJECT DESCRIPTION

CLIMATE

Latitude 52°3'N **Longitude** 0°45'W **Altitude** 100m **DD** 2000 **Base Temp.** 15.5°C

Sunshine Hours **July** 5.98 **January** 1.58 **Annual** 4.07

Source of data London data, building research establishment

Urban ____ **Suburban** x **Rural** ____

BUILDING

Floor area 120m² **No. Occupants** 4 - 5

Design Temperature **internal** **w** 18 **s** ____ °C

external **w** 5 **s** ____ °C

Mass **type** concrete block **location** inner skin

South Glazing **type** double

area(south glass) 18.4m² **% of total glass** 40%

night insulation --- **shaded** no

Heated Volume 300m³ **Ventilation Rate** 1 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) ____

Collector **type** ____ **area(net)** ____

orientation ____ **tilt** ____

Storage **type** ____ **capacity** ____

Auxiliary System **type** radiators **fuel type** gas **fuel cost** 1p/KWHR useful

PROJECT SCHEDULE

MILESTONES \ DATE	80	81	82	83		
Construction completion						
Monitoring period						
Final reports						

Report availability — Title (available from): (ERG031) Passive Solar in Milton Keynes, R. Everett - E.R.G. Open University Milton Keynes, Price 5

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: 6000/house (8 houses)

Description of data recording method: Microdata MI600L Data Logger Magnetic Cartridges

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	hourly	
	Outdoor Temperature	hourly	±1°C
	Incident radiation on horizontal surface	hourly	5%
	Incident radiation in plane of collector	hourly	5%
	Relative Humidity	hourly	5%
	Wind Speed	hourly	5%
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors		
	Temperature entering & leaving collectors		
	Storage		
	Flow rate inputs to storage		
	Temperature entering & leaving storage		
	Temperature readings in storage(1 or more)		
	Auxiliary energy supplied to storage		
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems		
	Temperature entering & leaving subsystems		
	Auxiliary energy supplied to subsystems		
BUILDING SYSTEM	Average DB inside temperature	hourly	±1°C
	Infiltration load	hourly ? perhaps	
	Auxiliary energy	hourly	
	Operating energy	hourly	
	Total building energy load	hourly	
	Internal energy gains	hourly	
	Solar gains	hourly	
	Solar as a % of total load	hourly	
	Thermal capacity of building	?	

ILLUSTRATION

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS SURVEY

PROJECT TITLE

Field Trial of Space and Water Heating Installations Utilizing Solar Energy at:

Address: Solar Court, Great Linford
Milton Keynes, Buckinghamshire

(Group 2 houses - Nos. 1, 2, 3 and Control Group (Non Solar) houses - Nos. 4, 5 and 6)

MAIN PARTICIPANTS

	1	2	3
Name Address	John Laing Research and Development, Ltd. Manor Way Borehamwood Herts WD6 1LN	John Laing Construction, Ltd. Page Street Mill Hill London NW7 2ER	Solar Energy Development Bay 8 16 South Wharf Road London W2 1PF
Phone	01 953 6144	01 959 3636	01 402 3203
Responsibility	Project Managers System Installation Monitoring Installation, and Monitoring	Site Construction	Architects

PROJECT DESCRIPTION

CLIMATE

Latitude 52° Longitude 0 Altitude approx. 75m a.sl. DD _____ Base Temp. _____

Sunshine Hours July _____ January _____ Annual _____

Source of data _____

Urban ____ Suburban ____ Rural x

BUILDING

Floor area 104m² No. Occupants varies over 3 houses (up to 5)

Design Temperature internal w 18-20 s N/A °C

external w -1 s N/A °C

Mass type brick/block location Milton Keynes, Bucks. UK

South Glazing type double

area(south glass) approx. 18m² % of total glass approx. 80%

night insulation owners provision shaded 600mm overhang

Heated Volume 488m³ approx. Ventilation Rate designed 1 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) heating + hot water

Collector type copper flat plate area(net) 18.5m²

orientation Due South tilt 45°

Storage type Water capacity 0.8m² and 6m³

Auxiliary System type 2 stage boiler fuel type gas fuel cost _____

PROJECT SCHEDULE

MILESTONES \ DATE	1980	1981	1982			
Construction completion						
Monitoring period		EXTENSION APPLIED FOR				
Final reports						

Report availability — Title (available from): Solar Court, Milton Keynes, Space Heating and Water Heating Field Trials - Energy Technology Support Unit, Aere Harwell, and John Laing Research and Development Limited

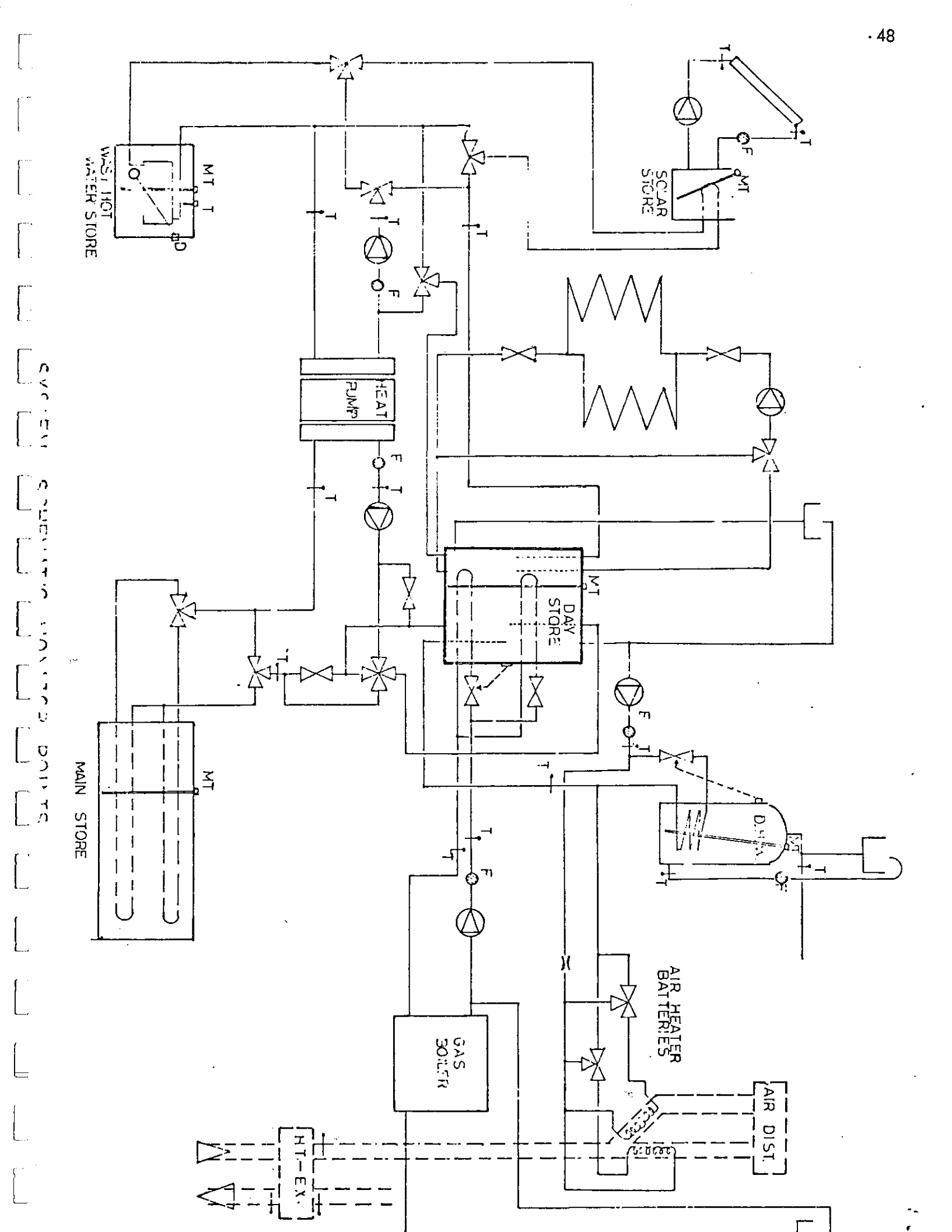
INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: 45,000

Description of data recording method: Magnetic tape via micro controlled logger. All houses ducted to central monitor station. Readings time based, continuous, on syst request

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	Daily	0.1°
	Outdoor Temperature	Hourly	0.1°
	Incident radiation on horizontal surface	2 minute intervals	4% 'KIPP + ZONEN'
	Incident radiation in plane of collector	2 minute intervals	4%
	Relative Humidity	Hourly	0.1%
	Wind Speed	Hourly and Wind Run	0.5%
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	continuous count	
	Temperature entering & leaving collectors	continuous count	
	Storage		
	Flow rate inputs to storage	on demand	
	Temperature entering & leaving storage	on demand	
	Temperature readings in storage(1 or more)	on demand	
	Auxiliary energy supplied to storage	on demand	
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	as used	
	Temperature entering & leaving subsystems	continuous in operation	
	Auxiliary energy supplied to subsystems	continuous in operation	
BUILDING SYSTEM	Average DB inside temperature	Hourly	
	Infiltration load	[illegible]	
	Auxiliary energy	Daily	
	Operating energy	as used	
	Total building energy load	Daily	
	Internal energy gains	--	
	Solar gains	calculated	
	Solar as a % of total load	calculated	
	Thermal capacity of building	--	


WASTE HOT WATER STORE
MT
T
SOLAR STORE
F
HEAT PUMP
DAY STORE
MAIN STORE
GAS BOILER
AIR HEATER BATTERIES
AIR DIST.
HT-EX.

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Field Trial of Space and Water Heating Installations Utilizing Solar Energy at:

Address

Solar Court, Great Linford
Milton Keynes, Buckinghamshire
(Group 3 houses - Nos. 7, 8, 9)

MAIN PARTICIPANTS

	1	2	3
Name / **Address** / **Phone**	The Calor Group, Ltd. Calor House, Windsor Road Slough, Berks. U.K.	Solar Energy Developments Bay 8, South Wharf Road London W2 1PF.	Fulmer Research Institute Stoke Poges, Slough, Berks. U.K.
Responsibility	System Manufacturer Installation and Monitoring	Co-Designers Architects	Co-Designers, Supply and Installation of Controls, Monitoring Electronics

PROJECT DESCRIPTION

CLIMATE

Latitude 52° Longitude 0 Altitude Approx. 75m a.s.l. DD _____ Base Temp. _____

Sunshine Hours July _____ January _____ Annual _____

Source of data _____

Urban ____ Suburban ____ Rural x

BUILDING

Floor area 104m² No. Occupants Varies over 3 houses (up to 5)

Design Temperature Internal w 18-20 s N/A °C

external w -1 s N/A °C

Mass type Brick/block location Milton Keynes, Bucks. UK

South Glazing type double

area(south glass) approx. 18m² % of total glass approx. 80%

night insulation owners provision shaded 600mm overhang

Heated Volume 488m³ Ventilation Rate designed 1 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) heating + hot water

Collector type copper flat plate area(net) 40m²

orientation Due South tilt 45°

Storage type water capacity 2.0m³

Auxiliary System type Gen Boiler fuel type -- fuel cost _____

PROJECT SCHEDULE

MILESTONES \ DATE	1980	1981	1982			
Construction completion						
Monitoring period						
Final reports						

Report availability — Title (available from): Solar Court, Milton Keynes, Space Heating and Water Heating Field Trials - Energy Technology Support Unit, Aere Harwell, and The Calor Group Limited

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: 25,000

Description of data recording method: Digital Magnetic Cassette

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	$1H^{-1}$	0.15%
	Outdoor Temperature	$1H^{-1}$	0.15%
	Incident radiation on horizontal surface	$1H^{-1}$ (integrated)	1%
	Incident radiation in plane of collector	$1H^{-1}$ (integrated)	1%
	Relative Humidity		
	Wind Speed		
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	heat meter, integrated $1H^{-1}$	<1%
	Temperature entering & leaving collectors		<1%
	Storage		
	Flow rate inputs to storage	--	--
	Temperature entering & leaving storage	--	--
	Temperature readings in storage(1 or more)	$1H^{-1}$	0.2%
	Auxiliary energy supplied to storage	$1H^{-1}$	1%
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	heat meter	1%
	Temperature entering & leaving subsystems	integrated $1H^{-1}$	
	Auxiliary energy supplied to subsystems	$1H^{-1}$	1%
BUILDING SYSTEM	Average DB inside temperature	--	--
	Infiltration load	--	--
	Auxiliary energy	$1H^{-1}$	1%
	Operating energy	$1H^{-1}$	1%
	Total building energy load	$1D^{-1}$	1%
	Internal energy gains	$1H^{-1}$	1%
	Solar gains	$1H^{-1}$	1%
	Solar as a % of total load	$1D^{-1}$	2%
	Thermal capacity of building	$1D^{-1}$	2%

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Low Energy House Laboratory (Heat Pump House)

Address: Building Research Establishment
Garston
Watford UK

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Dr. S. J. Wozniak Building Research Establishment Garston, Watford UK 09273-74040		
Responsibility			

PROJECT DESCRIPTION

CLIMATE

Latitude 51°42'N Longitude 00°23'W Altitude 78 m DD 2120 Base Temp. _____

Sunshine Hours July 204 January 46 Annual 1517

Source of data BRE Meterological Station

Urban ____ Suburban x Rural ____

BUILDING

Floor area 100 m^2 No. Occupants Simulated occupancy

Design Temperature Internal w 20 s _____ °C

external w -1 s _____ °C

Mass type Brick/insulated cavity/light-weight concrete location _____

South Glazing type single pane

area(south glass) 5.47m^2 % of total glass 54%

night insulation _____ shaded --

Heated Volume 235m^3 Ventilation Rate 1.0 (nominal) a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Preheat to heat pumps

Collector type Unglazed black painted area(net) 63m^2

orientation south tilt 54½°

Storage type NIL capacity --

Auxiliary System type Gas fuel type _____ fuel cost _____

PROJECT SCHEDULE

MILESTONES \ DATE						
Construction completion						
Monitoring period						
Final reports						

Report availability — Title (available from): Low Energy House Laboratories (BRE News 46) BRE, Garston, Watford

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: ₹ 25,000 for 4 houses + cost of sensors

Description of data recording method: PDP II Computer data logger

DATA RECORDED

Not yet finished

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days		
	Outdoor Temperature		
	Incident radiation on horizontal surface		
	Incident radiation in plane of collector		
	Relative Humidity		
	Wind Speed		
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors		
	Temperature entering & leaving collectors		
	Storage		
	Flow rate inputs to storage		
	Temperature entering & leaving storage		
	Temperature readings in storage(1 or more)		
	Auxiliary energy supplied to storage		
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems		
	Temperature entering & leaving subsystems		
	Auxiliary energy supplied to subsystems		
BUILDING SYSTEM	Average DB inside temperature		
	Infiltration load		
	Auxiliary energy		
	Operating energy		
	Total building energy load		
	Internal energy gains		
	Solar gains		
	Solar as a % of total load		
	Thermal capacity of building		

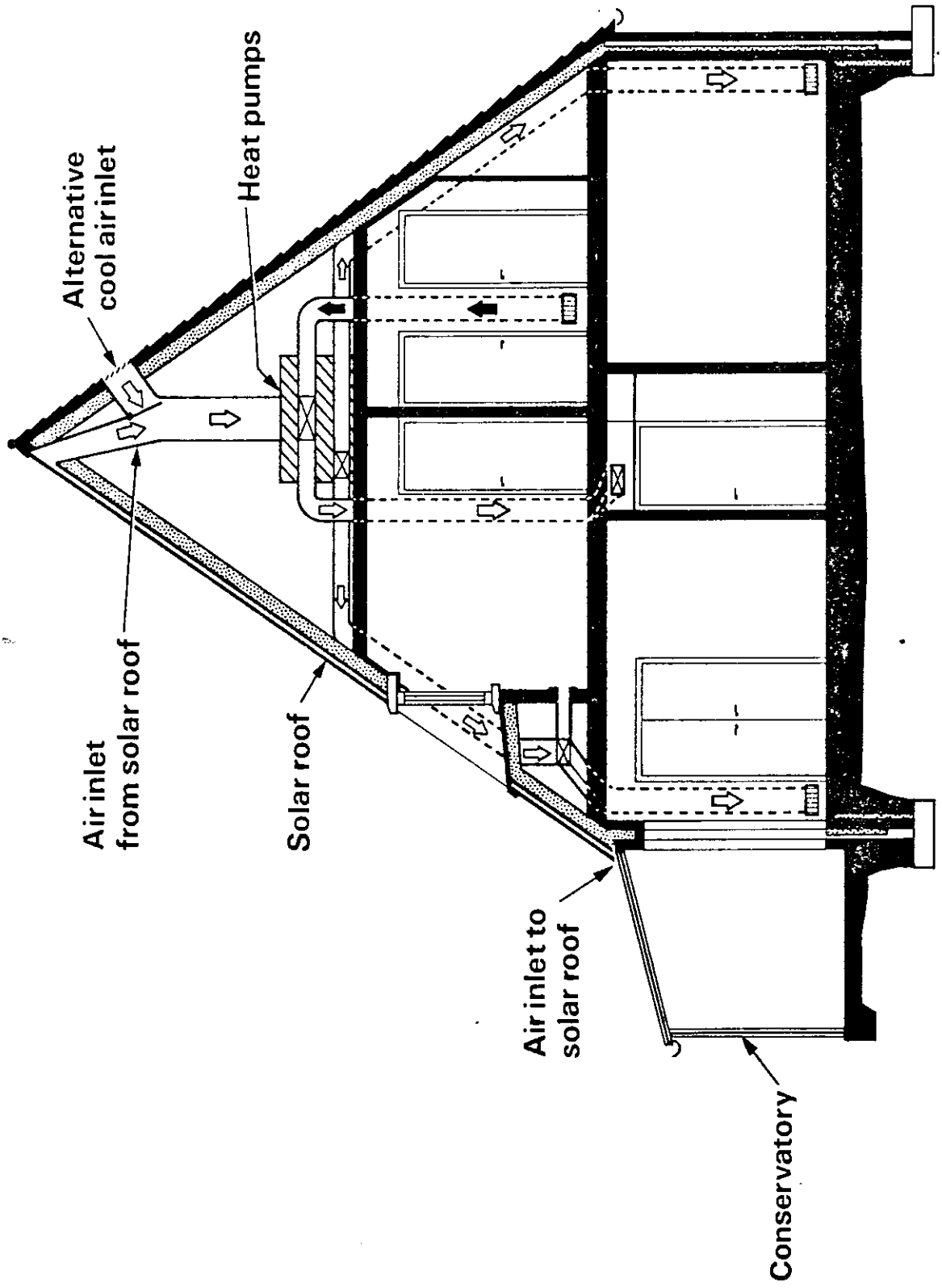


Figure 13 Heat pump house. Section showing layout of house, heat pumps and warm air ducting

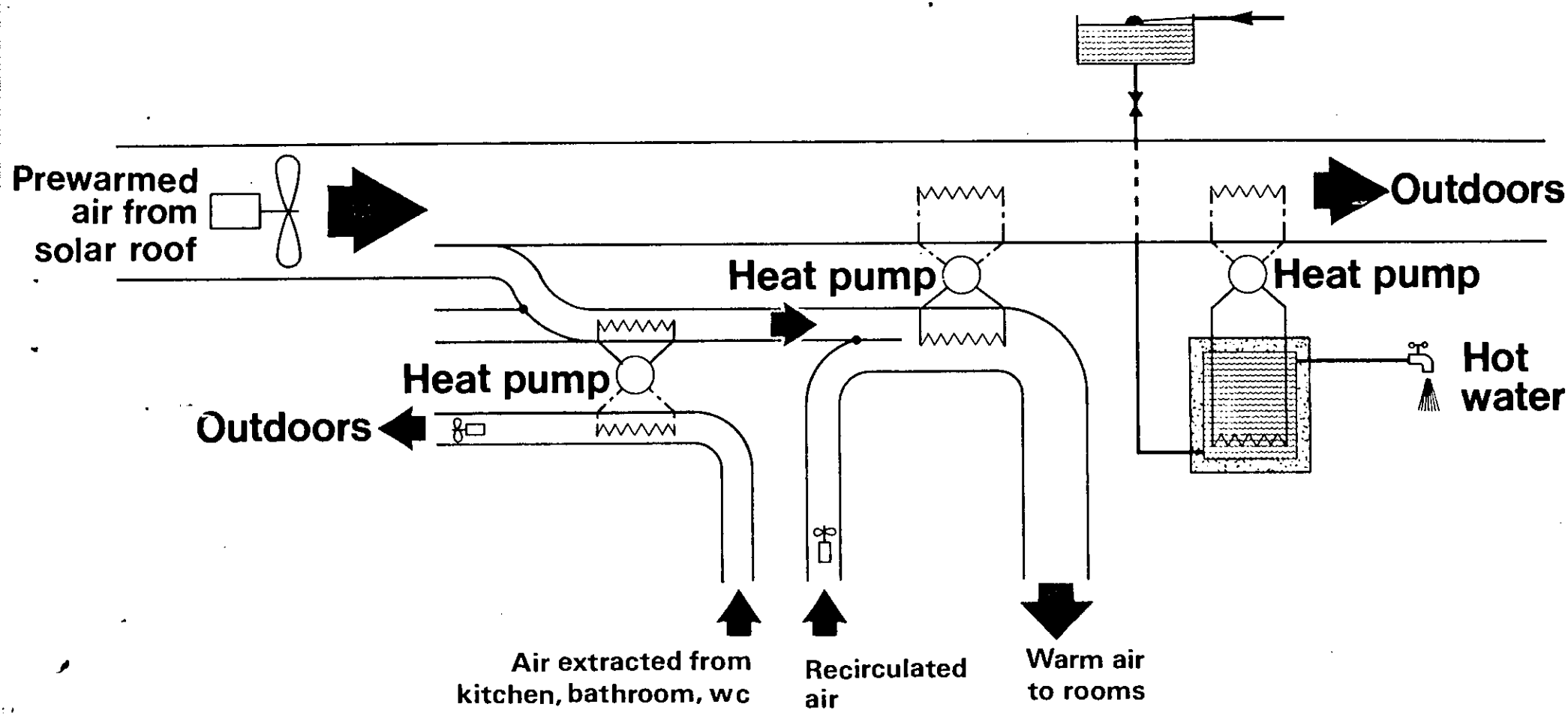


Figure 15 Heat pump house. Systems diagram for winter operation

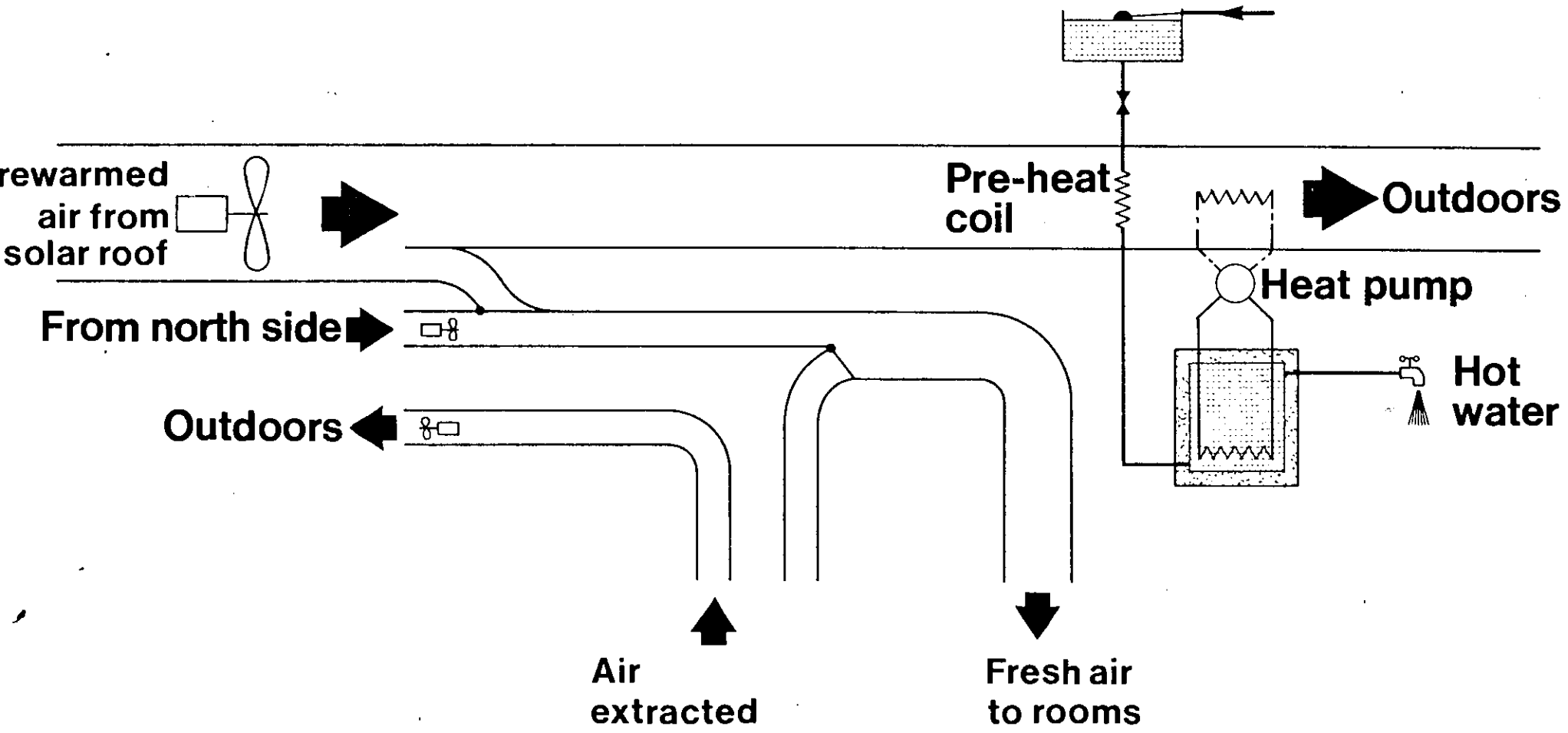


Figure 16 Heat pump house. Systems diagram for summer operation

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS SURVEY

PROJECT TITLE

Low Energy House Laboratory (Solar House)

Address: Building Research Establishment
Garston,
Watford. UK.

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Dr. S. J. Wozniak Building Research Establishment Garston, Watford UK 09273-74040		
Responsibility			

PROJECT DESCRIPTION

CLIMATE

Latitude 51°42'N Longitude 00°23'W Altitude 78 m DD 2120 Base Temp. _____

Sunshine Hours July 204 January 46 Annual 1517

Source of data BRE Meterological Station

Urban _____ Suburban x Rural _____

BUILDING

Floor area 88 m² No. Occupants Simulated occupancy

Design Temperature Internal w 20 s _____ °C

external w -1 s _____ °C

Mass type lightweight (timber frame) location _____

South Glazing type single pane

area(south glass) 3.72 m² % of total glass 43%

night insulation thin curtains shaded --

Heated Volume 207 m³ Ventilation Rate 1.0 (nominal) a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) space and water heating

Collector type selective surface single glazed area(net) 18 m²

orientation south tilt 42°

Storage type water capacity 40 m³, 2.3 m³, 0.3 m³

Auxiliary System type heat pump assistance fuel type elec. fuel cost _____

PROJECT SCHEDULE

MILESTONES \ DATE						
Construction completion						
Monitoring period						
Final reports						

Report availability — Title (available from): Low Energy House Laboratories (BRE News 46) BRE, Garston, Watford

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: ₹ 25,000 for 4 houses, + cost of sensors

Description of data recording method: PDP II Computer data logger

DATA RECORDED Not yet finished

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days		
	Outdoor Temperature		
	Incident radiation on horizontal surface		
	Incident radiation in plane of collector		
	Relative Humidity		
	Wind Speed		
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors		
	Temperature entering & leaving collectors		
	Storage		
	Flow rate inputs to storage		
	Temperature entering & leaving storage		
	Temperature readings in storage(1 or more)		
	Auxiliary energy supplied to storage		
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems		
	Temperature entering & leaving subsystems		
	Auxiliary energy supplied to subsystems		
BUILDING SYSTEM	Average DB inside temperature		
	Infiltration load		
	Auxiliary energy		
	Operating energy		
	Total building energy load		
	Internal energy gains		
	Solar gains		
	Solar as a % of total load		
	Thermal capacity of building		

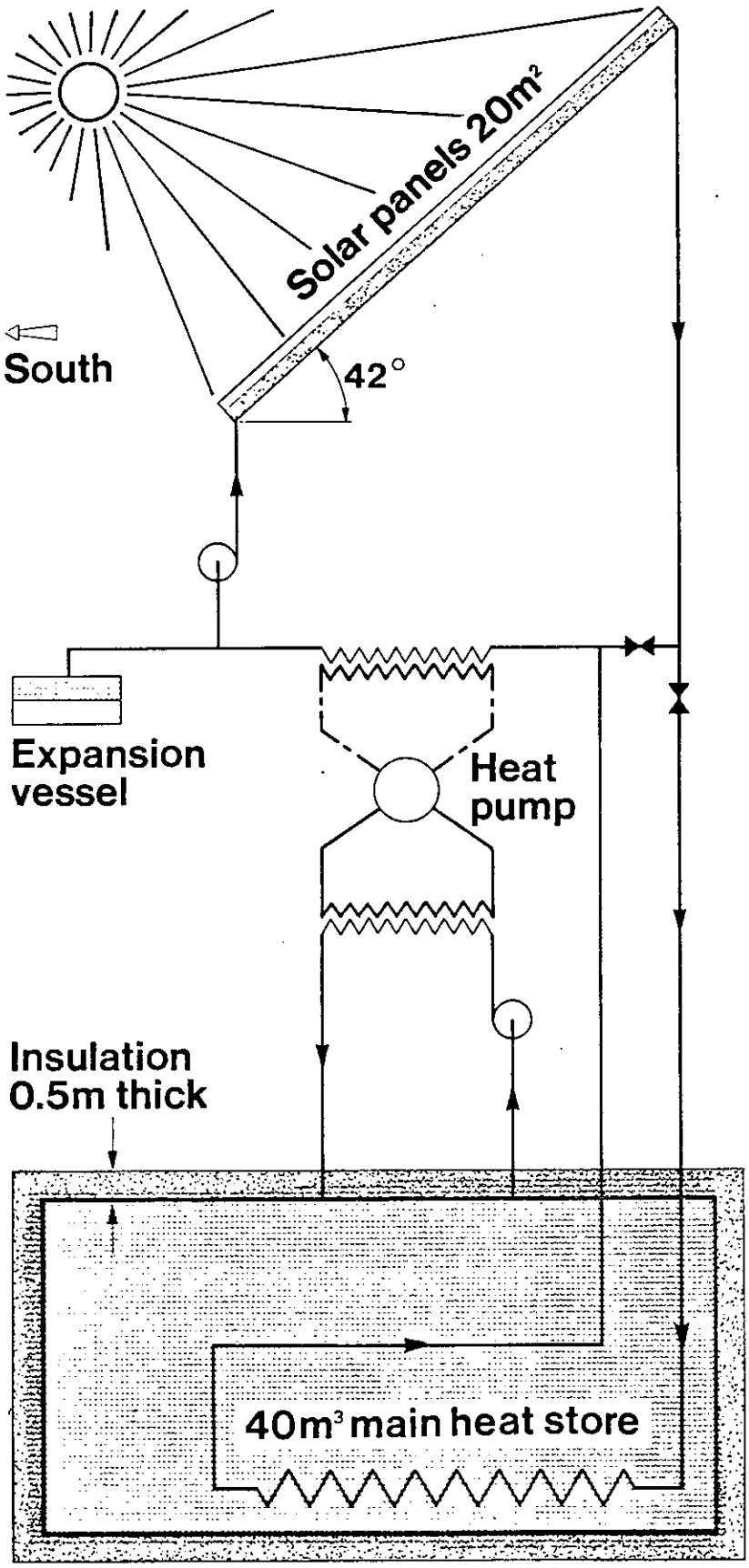


Figure 10 Solar house. Solar energy collection and storage

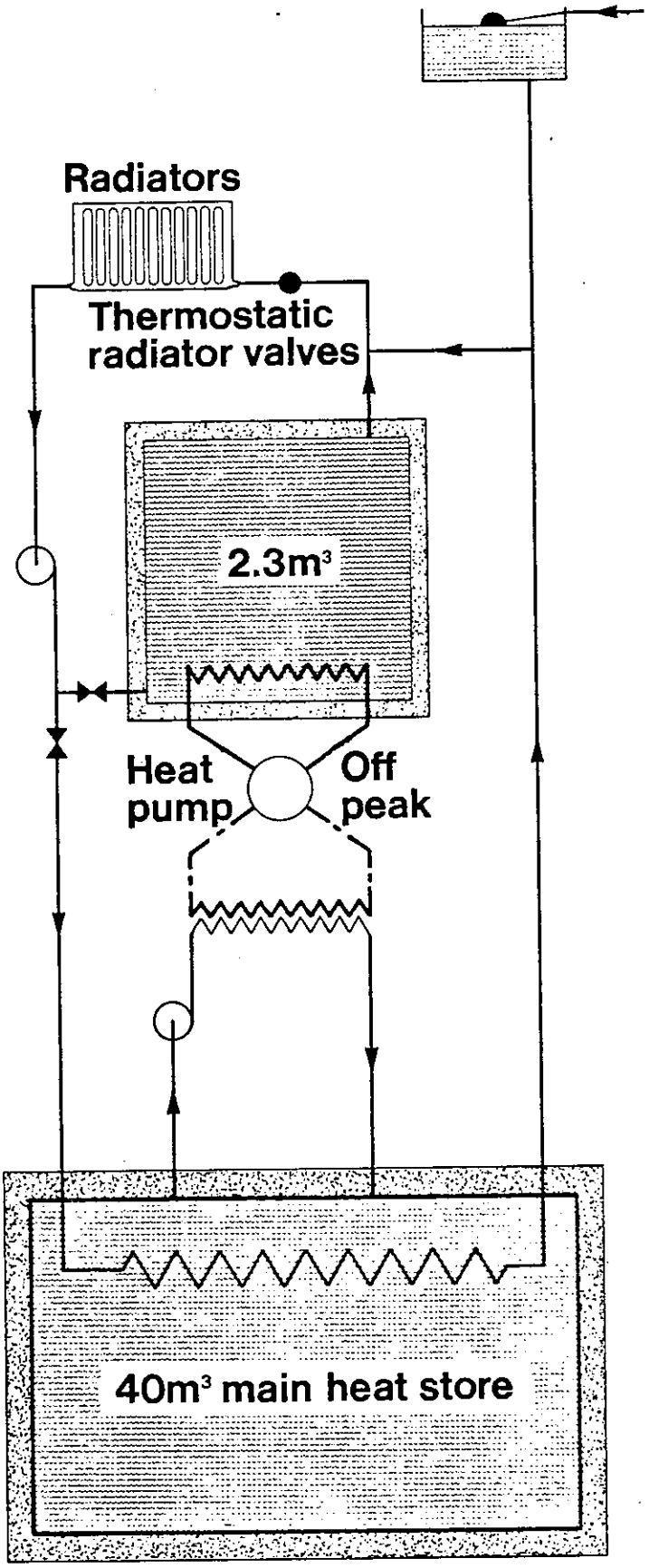


Figure 11 Solar house. Space heat system

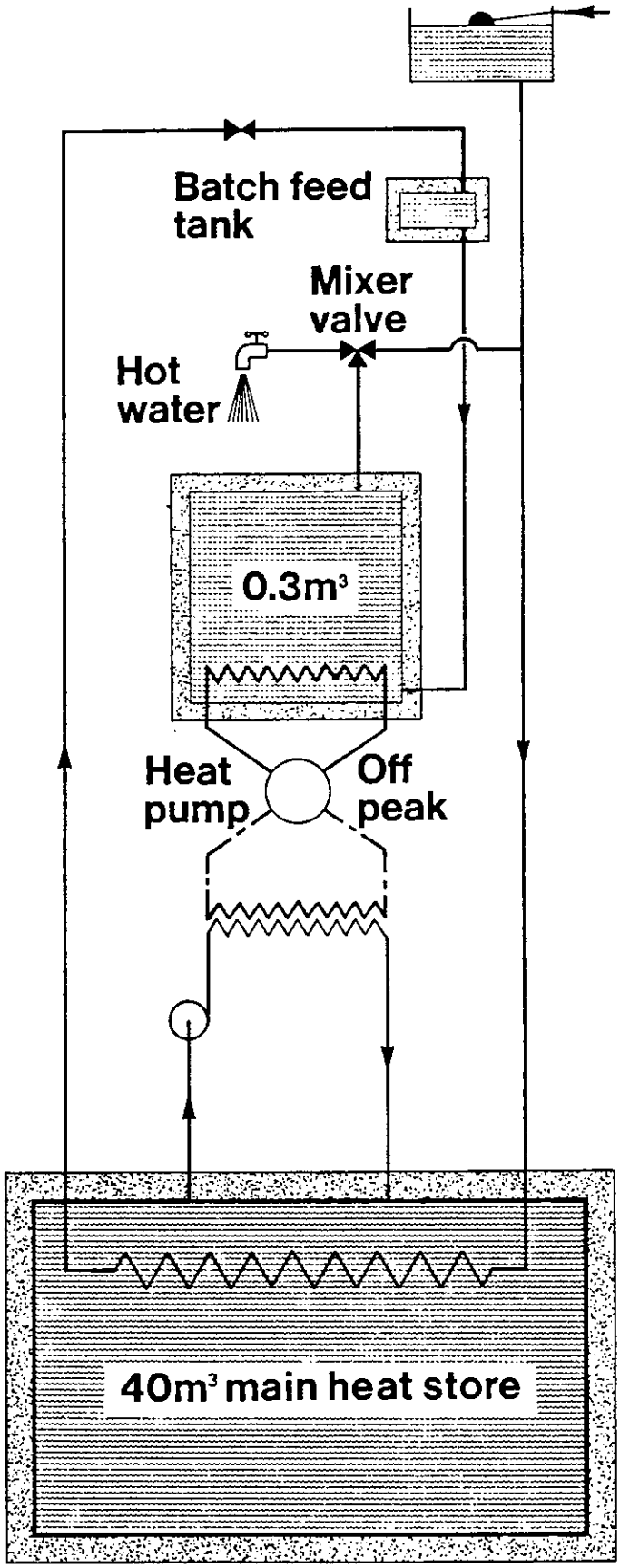


Figure 12 Solar house. Domestic hot water supply

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Pennyland

Address Milton Keynes
Bucks
England

MAIN PARTICIPANTS

	1	2	3
Name	Tereny Chatfield	Bob Everett	John Doggart
Address	Energy Research Group Open University Milton Keynes	Energy Research Group Open University Milton Keynes	Milton Keynes Development Corp. Cofferidge Close Stony Stratford Milton Keynes
Phone	0908 653335	0908 653335	0908 565454
Responsibility	Project Officer	Research Fellow	Project Supervisor

PROJECT DESCRIPTION

CLIMATE

Latitude 52°3'N **Longitude** 0°45'W **Altitude** 100m **DD** 2000 **Base Temp.** 15.5°C

Sunshine Hours **July** 5.98 **January** 1.58 **Annual** 4.07

Source of data London data, building research establishment

Urban _____ **Suburban** x **Rural** _____

BUILDING

Floor area 100m² * **No. Occupants** 3 - 4 *

Design Temperature **internal** w 18 s _____ °C

external w 5 s _____ °C

Mass **type** dense concrete **location** inner skin

South Glazing **type** single or double

area(south glass) 9 - 13m² **% of total glass** 30 - 40%

night insulation blinds or shutters **shaded** no

Heated Volume 250m³ * **Ventilation Rate** 1 a.c.h.

* Main Design Variant

SOLAR SYSTEM

System energy use(eg. heating) _____

Collector **type** _____ **area(net)** _____

orientation _____ **tilt** _____

Storage **type** _____ **capacity** _____

Auxiliary System **type** Gas radiators or warm air **fuel type** gas **fuel cost** 1p/KWHR useful

PROJECT SCHEDULE

MILESTONES \ DATE	1980	1981	1982	1983		
Construction completion						
Monitoring period						
Final reports						

Report availability — Title (available from): (ERG031) Passive Solar in Milton Keynes, R. Everett
Energy Research Group, Open University
Milton Keynes Price 5

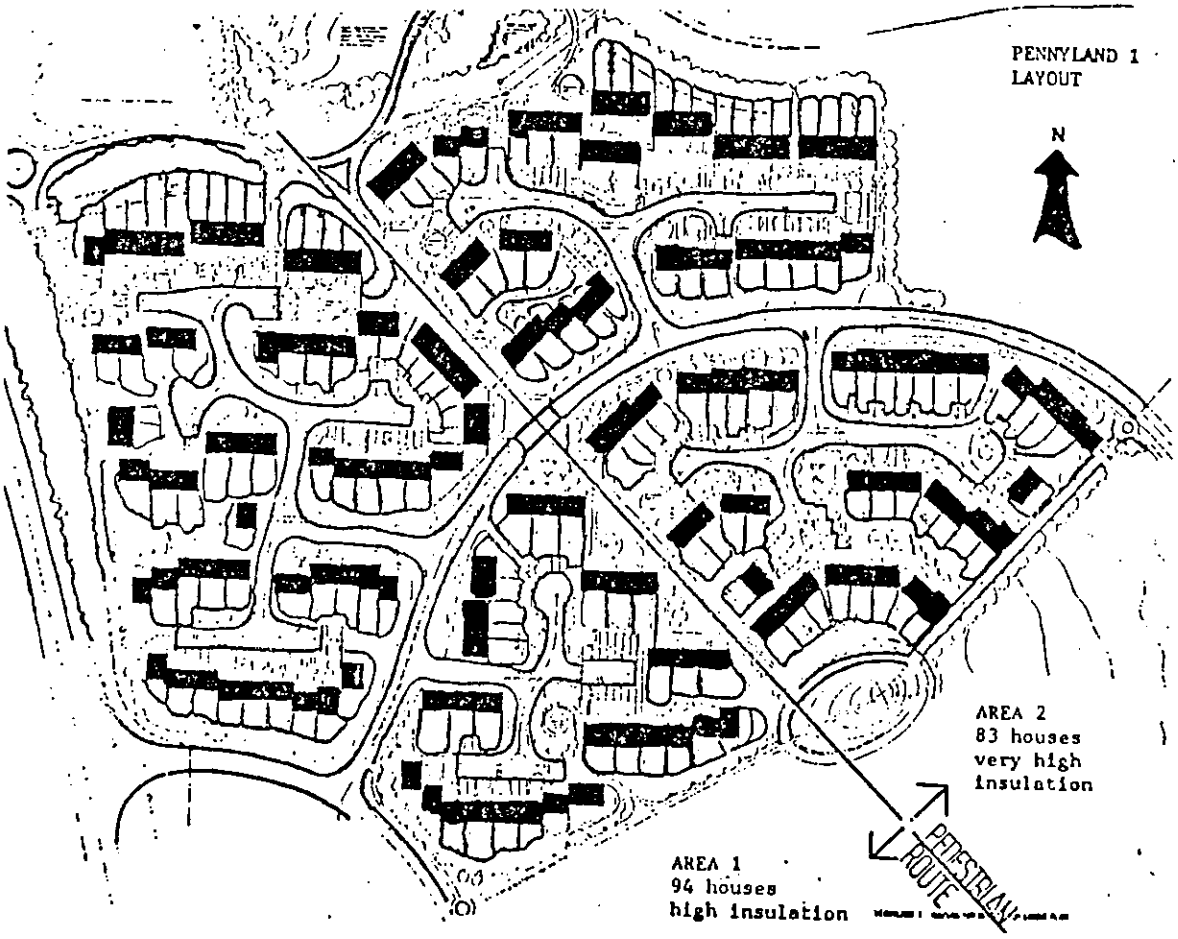
INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: 350/house
Description of data recording method: integrating displays in house meter cupboard

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days		
	Outdoor Temperature	hourly	±1°C
	Incident radiation on horizontal surface	hourly	5%
	Incident radiation in plane of collector (vertical)	hourly	5%
	Relative Humidity	hourly	5%
	Wind Speed	hourly	5%
	Recordings from Linford Project		
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors		
	Temperature entering & leaving collectors		
	Storage		
	Flow rate inputs to storage		
	Temperature entering & leaving storage		
	Temperature readings in storage(1 or more)		
	Auxiliary energy supplied to storage		
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems		
	Temperature entering & leaving subsystems		
	Auxiliary energy supplied to subsystems		
BUILDING SYSTEM	Average DB inside temperature	weekly	±1°C
	Infiltration load	--	
	Auxiliary energy	weekly	
	Operating energy	--	
	Total building energy load	weekly	
	Internal energy gains		
	Solar gains	hourly	
	Solar as a % of total load	weekly	
	Thermal capacity of building	--	

ILLUSTRATION



UNITED STATES

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

A-Frame Industries

Address: 46-198 Lilipuna
Kaneohe, HI 96774

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Berry Dean Root 46-198 Lilipuna Kaneohe, HI 96774 808-247-1635		
Responsibility	Occupant		

PROJECT DESCRIPTION

CLIMATE

Latitude 21.5n Longitude 158°w Altitude 500 ft DD -- Base Temp. 76°F

Sunshine Hours July _____ January _____ Annual _____

Source of data NOAA local climatological data

Urban _____ Suburban X Rural _____

BUILDING

Floor area unknown No. Occupants 2

Design Temperature internal w -- s -- ° --

external w -- s -- ° --

Mass type unknown location unknown

South Glazing type unknown

area(south glass) unknown % of total glass unknown

night insulation unknown shaded unknown

Heated Volume unknown Ventilation Rate unknown a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Domestic hot water

Collector type Miromet - 4 panel flat plate area(net) 68 ft²

orientation 10° E of south tilt 21°

Storage type Chromalox - domestic hot water system capacity 120 gal

Auxiliary System type electrical - 240V fuel type -- fuel cost --

PROJECT SCHEDULE

MILESTONES \ DATE	1977	1978	1979	1980		
Construction completion	8/77					
Monitoring period	No data	Feb-Dec	Jan-Nov	April-June		
Final reports	No data	Feb-Sept & Nov	Feb-May	April-June		

Report availability — Title: Monthly Performance Report (A-Frame Industries)
(available from): Technical Information Center
P.O. Box 62, Oak Ridge, TN 37830

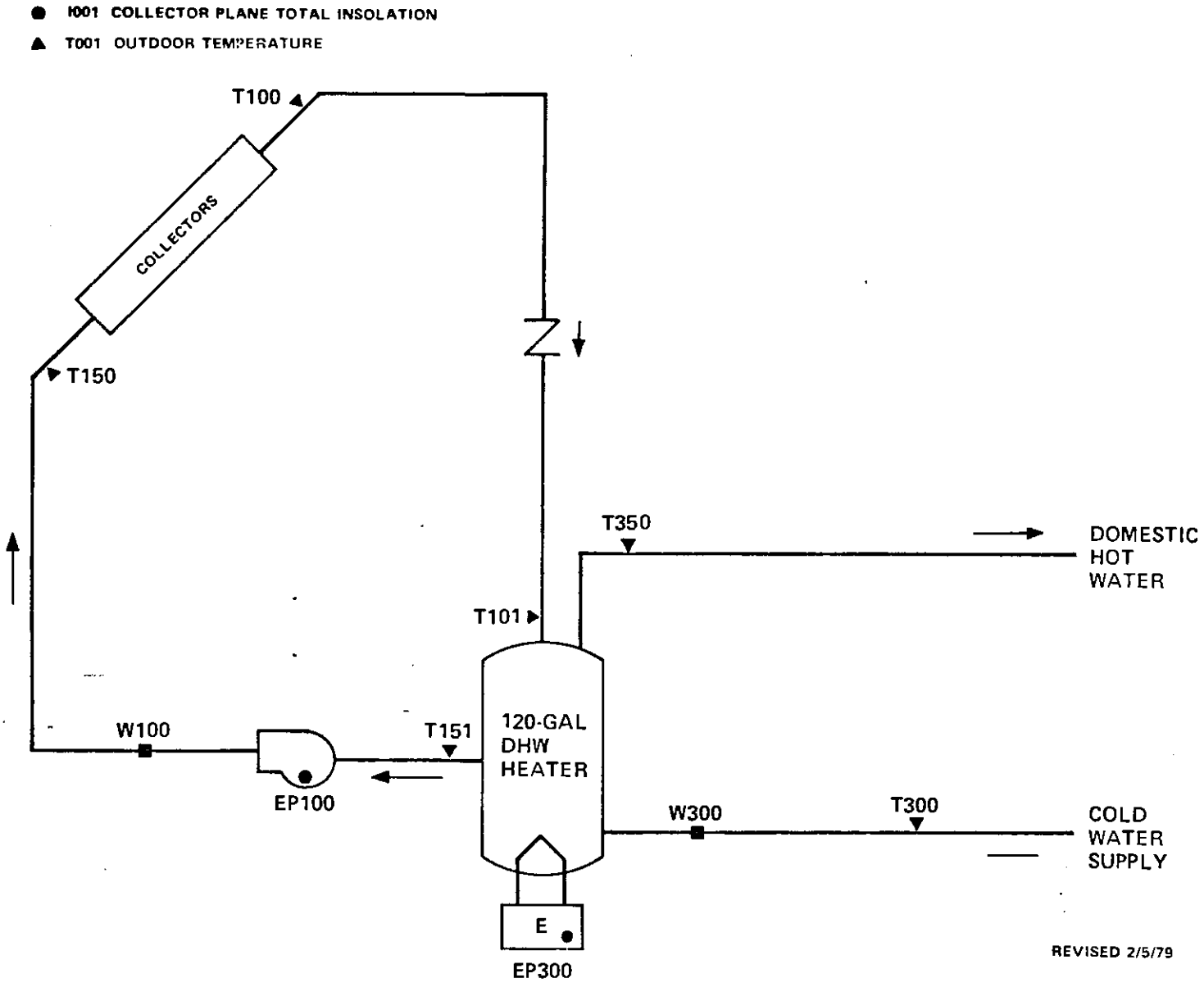
INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: $3510.00
Description of data recording method: Data collected on tape every 320 seconds, and sent to the Central Data Processing System daily

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	--	--
	Outdoor Temperature	320 sec	0.5°F
	Incident radiation on horizontal surface	--	--
	Incident radiation in plane of collector	320 sec	3%
	Relative Humidity	N/A	N/A
	Wind Speed	N/A	N/A
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	320 sec	3%
	Temperature entering & leaving collectors	320 sec	0.5°F
	Storage		
	Flow rate inputs to storage	320 sec	3%
	Temperature entering & leaving storage	320 sec	0.5°F
	Temperature readings in storage(1 or more)	320 sec	0.5°F
	Auxiliary energy supplied to storage	N/A	N/A
	Space heat, Space cooling, Hot water Subsystems		
	Flow rates entering subsystems	N/A	N/A
	Temperature entering & leaving subsystems	N/A	N/A
	Auxiliary energy supplied to subsystems	N/A	N/A
BUILDING SYSTEM	Average DB inside temperature	N/A	N/A
	Infiltration load	N/A	N/A
	Auxiliary energy	N/A	N/A
	Operating energy	N/A	N/A
	Total building energy load	N/A	N/A
	Internal energy gains	N/A	N/A
	Solar gains	N/A	N/A
	Solar as a % of total load	N/A	N/A
	Thermal capacity of building	N/A	N/A

ILLUSTRATION



A-Frame Industries Solar Energy System Schematic

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Albuquerque Western II

Address: 110 Texas St., N.E.
Albuquerque, NM 87110

MAIN PARTICIPANTS

	1	2	3
Name	Brad Shaw		
Address	110 Texas St., N.E. Albuquerque, NM 87110		
Phone	550-266-1976		
Responsibility	Manager		

PROJECT DESCRIPTION

CLIMATE

Latitude 35° Longitude 106° Altitude 5339 ft DD 4383 Base Temp. 65°F

Sunshine Hours July 11.2 January 5.1 Annual 8.0

Source of data NOAA local climatological data

Urban X Suburban ____ Rural ____

BUILDING

Floor area 630 ft²/unit No. Occupants unknown

Design Temperature internal w 75 s 78 °F

external w 10 s 100 °F

Mass type composit (brick/concrete) location Albuquerque, NM

South Glazing type unknown

area(south glass) unknown % of total glass unknown

night insulation unknown shaded unknown

Heated Volume unknown Ventilation Rate 15000 CFM a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Space heating

Collector type Solcan, concentrating & tracking area(net) 5732.6 ft²

orientation south tilt 35°

Storage type concrete storage tank capacity 57000 gal

Auxiliary System type gas-fired hot water boiler fuel type natural gas fuel cost $2.93/ft³

PROJECT SCHEDULE

MILESTONES \ DATE	1978	1979	1980	1979	1980	
Construction completion	unknown					
Monitoring period	Jan-Dec	Jan-Dec	Jan-Aug			
Final reports	May-Dec	Jan-Mar & Dec	Feb-Aug	Seasonal Oct.78-Mar.79	Seasonal Oct.79-Mar.80	

Report availability — Title: Monthly Performance Report (Albuquerque Western II)
(available from) Techinical Information Center
P.O. Box 62, Oak Ridge, TN 37830

INSTRUMENTATION (existing or anticipated)

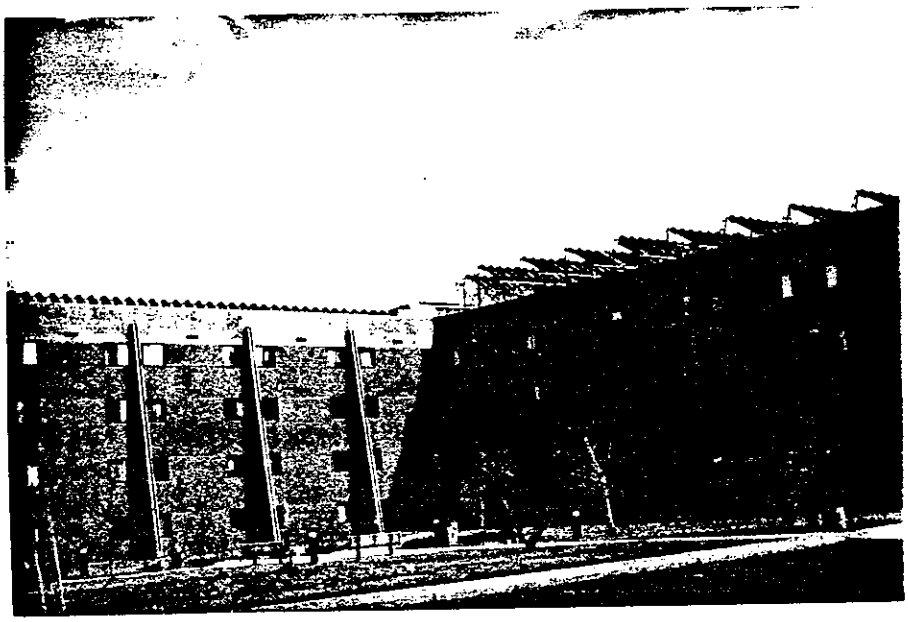
Approximate cost of instrumentation package ____

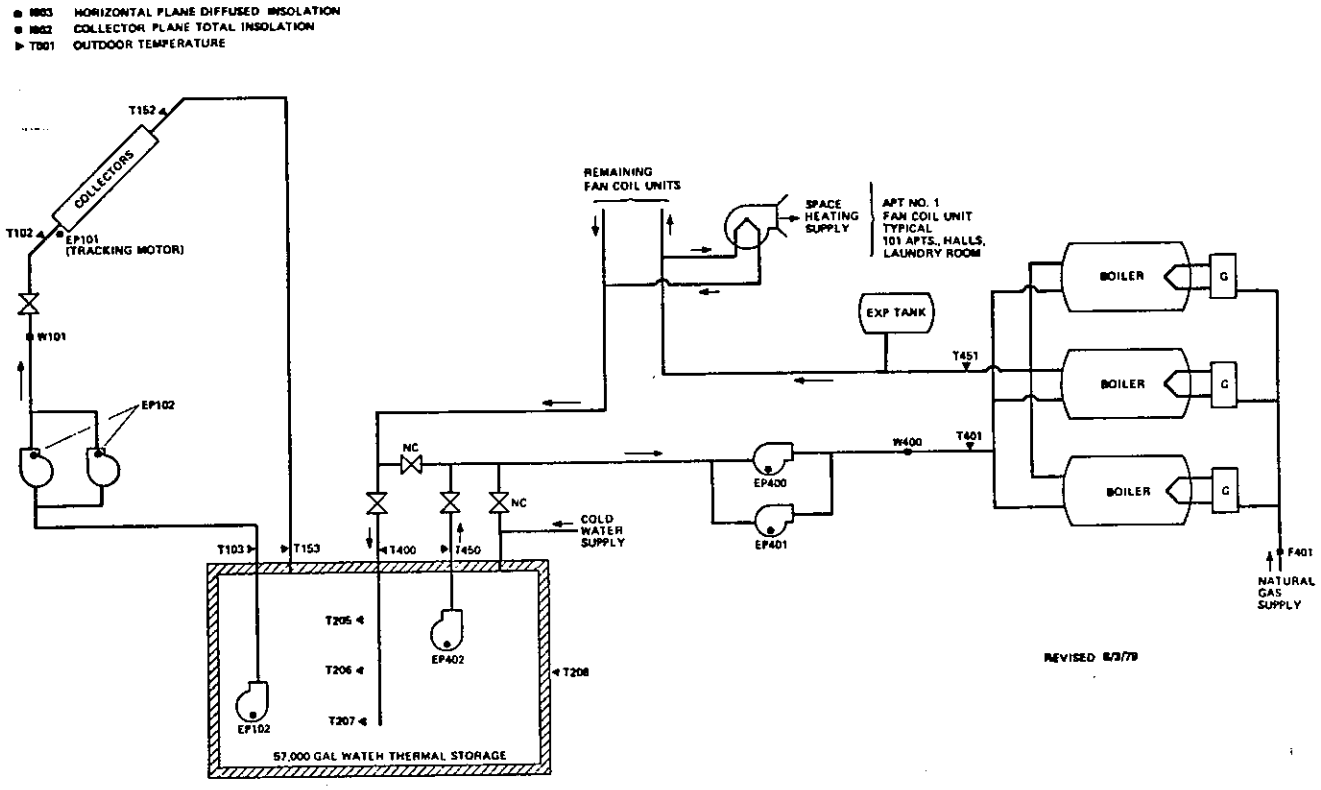
Description of data recording method: Data collected on tape every 320 seconds and sent to the Central Data Processing System daily

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	--	--
	Outdoor Temperature	320 sec	± 0.5°F
	Incident radiation on horizontal surface	--	--
	Incident radiation in plane of collector	320 sec	± 2%
	Relative Humidity	--	--
	Wind Speed	--	--
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	320 sec	± 3%
	Temperature entering & leaving collectors	320 sec	± 0.5°F
	Storage		
	Flow rate inputs to storage	320 sec	± 3%
	Temperature entering & leaving storage	320 sec	± 0.5°F
	Temperature readings in storage(1 or more)	320 sec	± 0.5°F
	Auxiliary energy supplied to storage	--	--
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	320 sec	± 3%
	Temperature entering & leaving subsystems	320 sec	± 0.5°F
	Auxiliary energy supplied to subsystems	320 sec	± 1%
BUILDING SYSTEM	Average DB inside temperature	--	--
	Infiltration load	--	--
	Auxiliary energy	--	--
	Operating energy	--	--
	Total building energy load	--	--
	Internal energy gains	--	--
	Solar gains	--	--
	Solar as a % of total load	--	--
	Thermal capacity of building	--	--

ILLUSTRATION





Albuquerque Western II Solar Energy System Schematic

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Cathedral Square

Address: 3 Cathedral Square
Burlington, VT 05401

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Steve Schuh Boeing Aerospace Company P.O. Box 3999 MS-8612 Seattle, WA 98124 206-773-0640	James Brown, PE Jennison Engineering Inc. 182 Main Street Burlington, VT 05401 802-863-4571	Robert Wheeler Yankee Solar Systems 121 Pearl Street Burlington, VT 05401 802-864-4522
Responsibility	File Representative	Solar System Designer	Solar Subcontractor

PROJECT DESCRIPTION

CLIMATE

Latitude 44°N Longitude 73° Altitude 200 ft DD 8269 Base Temp. 65°

Sunshine Hours July _____ January _____ Annual _____

Source of data NOAA climiatological data

Urban X Suburban ____ Rural ____

BUILDING

Floor area unknown No. Occupants 114

Design Temperature internal w -- s -- ° --

external w -- s -- ° --

Mass type unknown location Burlington, VT

South Glazing type unknown

area(south glass) unknown % of total glass unknown

night insulation unknown shaded unknown

Heated Volume unknown Ventilation Rate unkown a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Domestic hot water

Collector type Daystar, flat plate area(net) 1798 ft²

orientation 42°W of south tilt 45°

Storage type water capacity 2699 gal

Auxiliary System type boiler fuel type gas fuel cost unknown

PROJECT SCHEDULE

MILESTONES \ DATE	1979	1980				
Construction completion	unknown					
Monitoring period	Jun-Dec	Jan-Aug				
Final reports	Jun-Oct	Jan-Aug				

Report availability — Title: Monthly Performance Report (Cathedral Square)
(available from): Techinical Information Center
P.O. Box 62, Oak Ridge, TN 37830

INSTRUMENTATION (existing or anticipated)

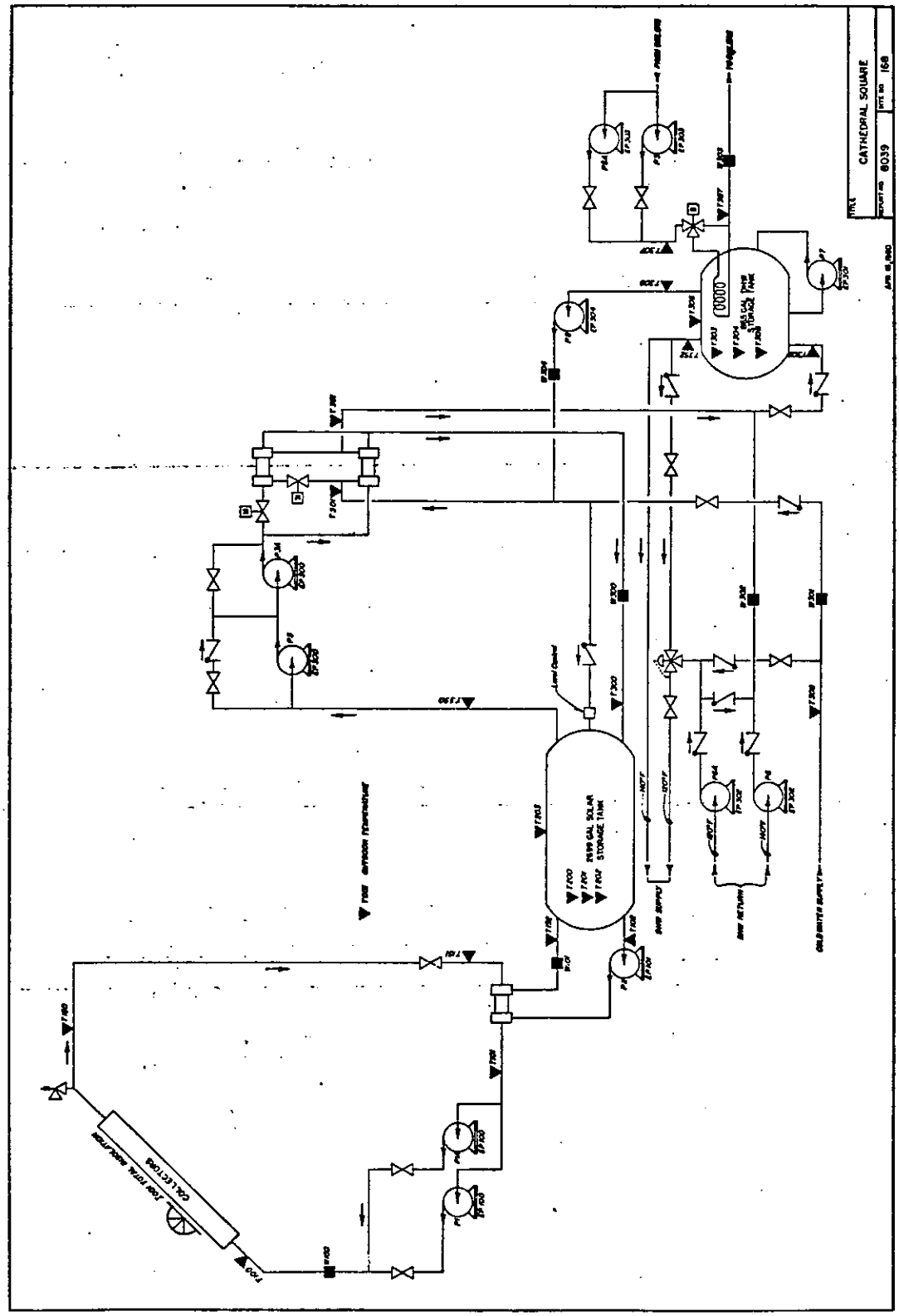
Approximate cost of instrumentation package: ____

Description of data recording method: Data collected on tape every 320 seconds and sent to the Central Data Processing System daily

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	--	--
	Outdoor Temperature	320 sec	±0.5°F calibrated
	Incident radiation on horizontal surface	--	--
	Incident radiation in plane of collector	320 sec	± 3%
	Relative Humidity	--	--
	Wind Speed	--	--
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	320 sec	± 3% full scale
	Temperature entering & leaving collectors	320 sec	± 0.5°F
	Storage		
	Flow rate inputs to storage	320 sec	± 3% full scale
	Temperature entering & leaving storage	320 sec	± 0.5°F
	Temperature readings in storage(1 or more)	320 sec	± 0.5°F
	Auxiliary energy supplied to storage	--	--
	Space heat, Space cooling, Hot water Subsystems		
	Flow rates entering subsystems	320 sec	± 3% full scale
	Temperature entering & leaving subsystems	320 sec	± 0.5°F
	Auxiliary energy supplied to subsystems	--	--
BUILDING SYSTEM	Average DB inside temperature	--	--
	Infiltration load	--	--
	Auxiliary energy	--	--
	Operating energy	320 sec	±1%
	Total building energy load	--	--
	Internal energy gains	--	--
	Solar gains	--	--
	Solar as a % of total load	--	--
	Thermal capacity of building	--	--

ILLUSTRATION



IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Facilities Development

Address: 5750 Friars Road
San Diego, CA 92108

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Jeff Andrews 5750 Friars Road San Diego, CA 92108 714-295-4483		
Responsibility	President of condominium		

PROJECT DESCRIPTION

CLIMATE

Latitude 32° Longitude 117° Altitude 13 ft DD 1507 Base Temp. 65°F

Sunshine Hours July 10.9 January 5.3 Annual 8.0

Source of data NOAA local climatological data

Urban ____ Suburban X Rural ____

BUILDING

Floor area 1100 sq ft/unit No. Occupants unknown

Design Temperature internal w ____ s ____ °

external w 43 s ____ ° F

Mass type unknown location San Diego, CA

South Glazing type unknown

area(south glass) unknown % of total glass unknown

night insulation unknown shaded unknown

Heated Volume unknown Ventilation Rate unknown a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Domestic hot water

Collector type Revere, flat plate area(net) 520 ft²

orientation south tilt 46°

Storage type glass-lined, insulated & buried capacity 1000 gal

Auxiliary System type electric heaters fuel type electric fuel cost 5¢/kwh

PROJECT SCHEDULE

MILESTONES \ DATE	1978	1979	1980	Seasonal 1979		
Construction completion	unknown					
Monitoring period	Jan-Dec	Jan-Dec	Jan-Aug			
Final reports	Mar-Sept	Jan-Oct	Feb-Jun & Aug	Sesonal Oct 1978-Mar 1979		

Report availability — Title: Monthly Performance Report (Facilities Development)
(available from): Technical Information Center
P.O. Box 62, Oak Ridge, TN 87830

INSTRUMENTATION (existing or anticipated)

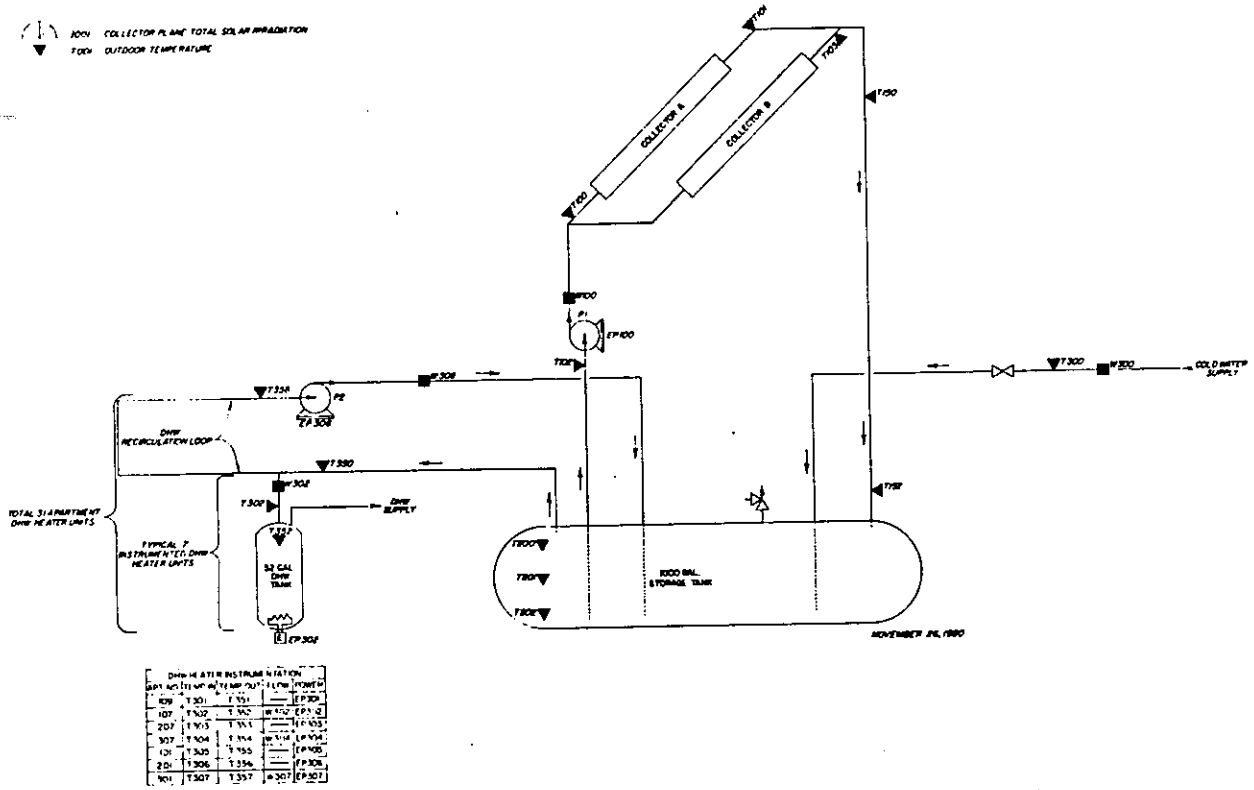
Approximate cost of instrumentation package: ____

Description of data recording method: Data collected on tape every 320 seconds and sent to the Central Data Processing System daily

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	--	--
	Outdoor Temperature	320 sec	± 0.5°F
	Incident radiation on horizontal surface	--	--
	Incident radiation in plane of collector	320 sec	± 2%
	Relative Humidity	--	--
	Wind Speed	--	--
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	320 sec	± 3%
	Temperature entering & leaving collectors	320 sec	± 0.5°F
	Storage		
	Flow rate inputs to storage	320 sec	± 3%
	Temperature entering & leaving storage	320 sec	± 0.5°F
	Temperature readings in storage(1 or more)	320 sec	± 0.5°F
	Auxiliary energy supplied to storage	--	--
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	320 sec	± 3%
	Temperature entering & leaving subsystems	320 sec	± 0.5°F
	Auxiliary energy supplied to subsystems	320 sec	± 2%
BUILDING SYSTEM	Average DB inside temperature	--	--
	Infiltration load	--	--
	Auxiliary energy	--	--
	Operating energy	--	--
	Total building energy load	--	--
	Internal energy gains	--	--
	Solar gains	--	--
	Solar as a % of total load	--	--
	Thermal capacity of building	--	--

ILLUSTRATION



DHW HEATER INSTRUMENTATION				
109	T301	T351	—	EP309
107	T302	T352	W302	EP302
207	T303	T353	—	EP303
307	T304	T354	W304	EP304
101	T305	T355	—	EP305
201	T306	T356	—	EP306
301	T307	T357	W307	EP307

Facilities Development Solar Energy System Schematic

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Forest City Dillon

Address: 3001 Bladensburg Road, N. E.
Washington, D. C.
(Fort Lincoln Apartments)

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Forest City Dillon, Inc. 10800 Brookpark Road Cleveland, Ohio 44130 Ken Yarus or Max Rabner (216) 267-1200	Perry Noe c/o Andrew Bryant & Associates (216) 653-3149	
Responsibility	Builder	Designer	

PROJECT DESCRIPTION

CLIMATE

Latitude 39°N Longitude 77° Altitude 200 ft. DD 4,600 Base Temp. 15°F

Sunshine Hours July 72% January 41% Annual 58%

Source of data HUD Documentation/U. S. Weather Data

Urban X Suburban ____ Rural ____

BUILDING

Floor area approx. 135,000 ft² No. Occupants approx. 188

Design Temperature internal w 68 s 78 °F

external w 15 s 91 °F

Mass type unknown location none

South Glazing type unknown

area(south glass) unknown % of total glass unknown

night insulation none shaded none

Heated Volume unknown Ventilation Rate unknown a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Domestic hot water

Collector type Lennox LSC181S area(net) 2,217 ft²

orientation South tilt 40 degrees

Storage type Liquid capacity 3,200 gallons (water)

Auxiliary System type Oil burner fuel type #2 oil fuel cost unknown

PROJECT SCHEDULE

MILESTONES \ DATE						
Construction completion	unknown	unknown				
Monitoring period	1/79-12/79	1/80-12/80				
Final reports	None	3/81				

Report availability — Title (available from): Monthly Performance Reports, 12/79 to Present; U. S. Department of Energy; T. I. C., P. O. Box 62, Oak Ridge, TN 37830

INSTRUMENTATION (existing or anticipated)

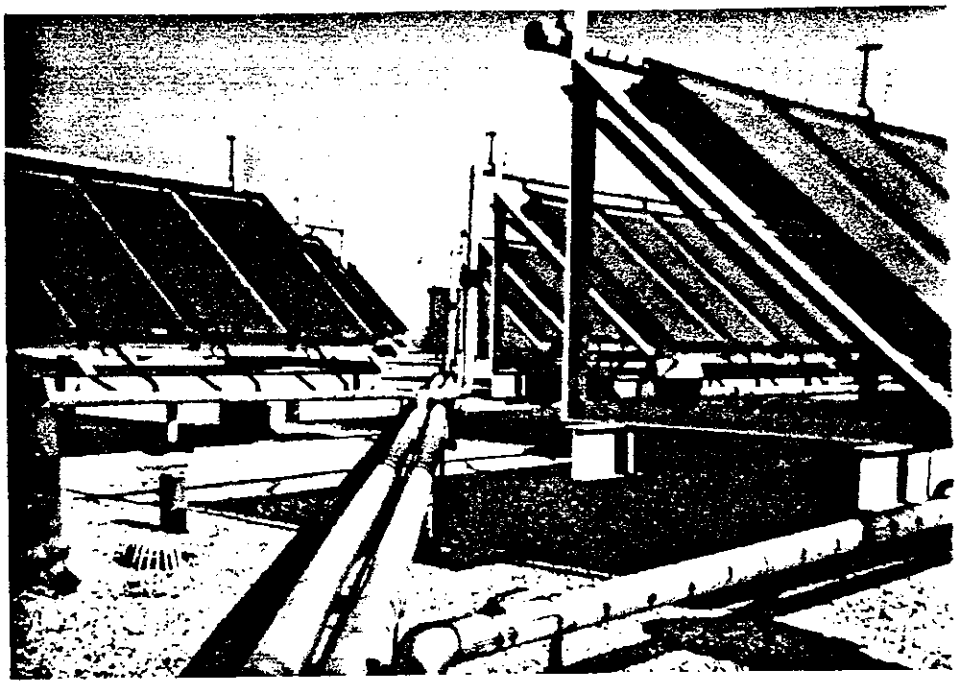
Approximate cost of instrumentation package: $30,000

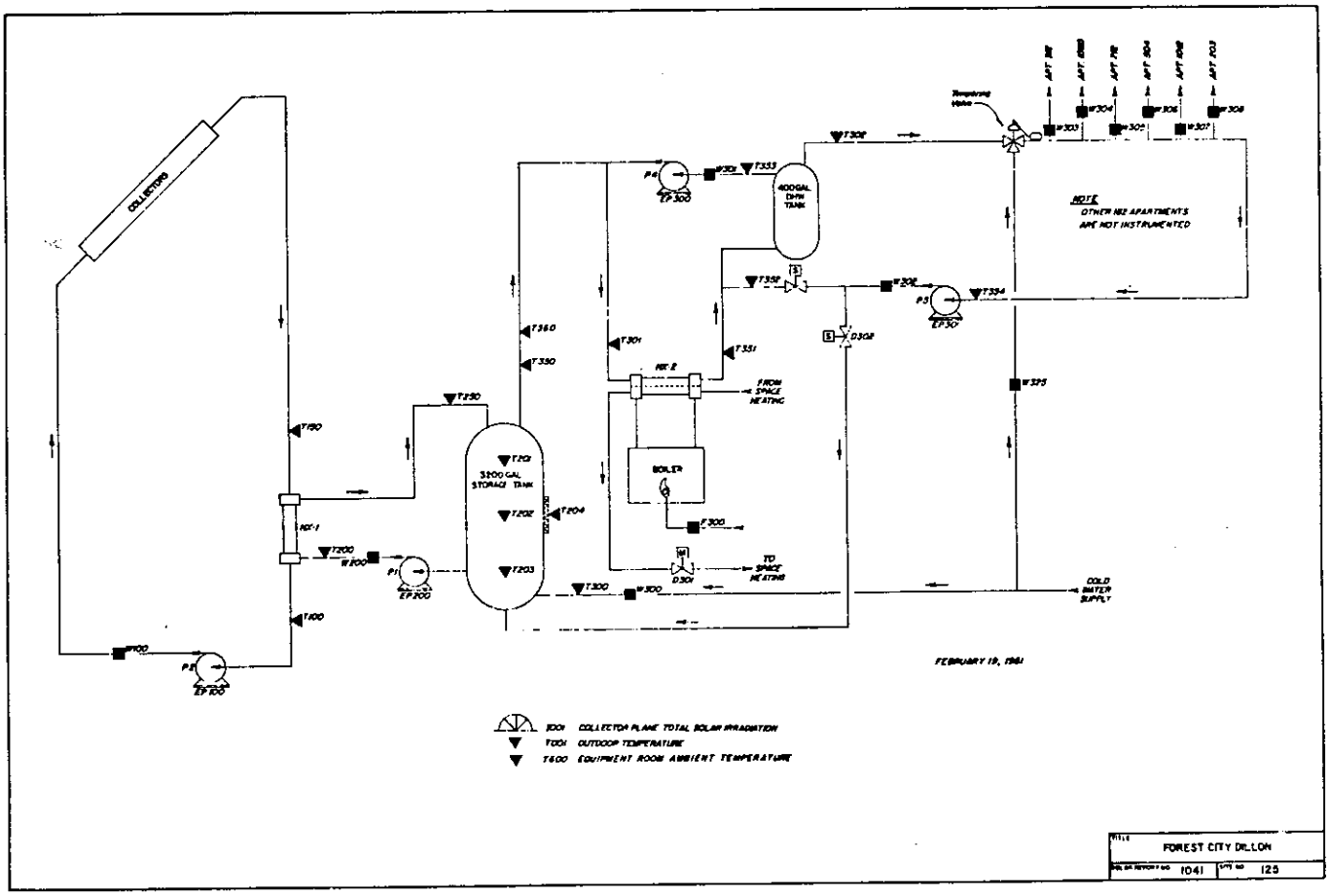
Description of data recording method: 320 second intervals

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	-	-
	Outdoor Temperature	320 sec.	5%
	Incident radiation on horizontal surface	-	-
	Incident radiation in plane of collector	320 sec.	5%
	Relative Humidity	320 sec.	5%
	Wind Speed	320 sec.	5%
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	320 sec.	5%
	Temperature entering & leaving collectors	320 sec.	5%
	Storage		
	Flow rate inputs to storage	320 sec.	5%
	Temperature entering & leaving storage	320 sec.	5%
	Temperature readings in storage(1 or more)	320 sec.	5%
	Auxiliary energy supplied to storage	320 sec.	5%
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	320 sec.	5%
	Temperature entering & leaving subsystems	320 sec.	5%
	Auxiliary energy supplied to subsystems	320 sec.	5%
BUILDING SYSTEM	Average DB inside temperature	-	-
	Infiltration load	-	-
	Auxiliary energy	-	-
	Operating energy	-	-
	Total building energy load	-	-
	Internal energy gains	-	-
	Solar gains	-	-
	Solar as a % of total load	-	-
	Thermal capacity of building	-	-

ILLUSTRATION





IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS SURVEY

PROJECT TITLE

Hei Wai Wong
Banyan Street Manor
1132 Banyan Street
Honolulu, Hawaii 96814

Address

MAIN PARTICIPANTS

	1	2	3
Name Address	Glenn A. Rome Boeing Aerospace Company P.O. Box 3999 MS 8612 Seattle, WA 98124	Mike Bean Cody Company 1168 Waimann Honolulu, HI 96814	Eleanor Lisenbee Resident Manager Banyan Street Manor 1132 Banyan St. Honolulu, HI 96814
Phone	206-773-0640	808-537-5285	808-841-7075
Responsibility	Field Representative	System Designer	Building Manager

PROJECT DESCRIPTION

CLIMATE

Latitude 22°N Longitude 157°W Altitude 60 ft DD -- Base Temp. 65°F

Sunshine Hours July _____ January _____ Annual _____

Source of data NOAA local climatological data

Urban X Suburban ____ Rural ____

BUILDING

Floor area unknown No. Occupants 19

Design Temperature internal w -- s -- ° --

external w -- s -- ° --

Mass type unknown location Honolulu, HI

South Glazing type unknown

area(south glass) unknown % of total glass unknown

night insulation unknown shaded unknown

Heated Volume unknown Ventilation Rate unknown a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Domestic hot water

Collector type Raypak, flat-plate area(net) 807 ft²

orientation south tilt 24°

Storage type water capacity 1230 gal

Auxiliary System type gas heater/elec. hot water heater fuel type gas/elec fuel cost unknown

PROJECT SCHEDULE

MILESTONES \ DATE	1977	1978	1979	1980		
Construction completion	unkown					
Monitoring period	Oct-Dec	Jan-Dec	Jan-Dec	Jan-Aug		
Final reports	None	Apr-Sept	Feb-Sept, Nov & Dec	Apr-Aug		

Report availability — Title: Monthly Performance Report (Hei Wai Wong)
(available from): Technical Information Center
P.O. Box 62, Oak Ridge, TN 37830

INSTRUMENTATION (existing or anticipated)

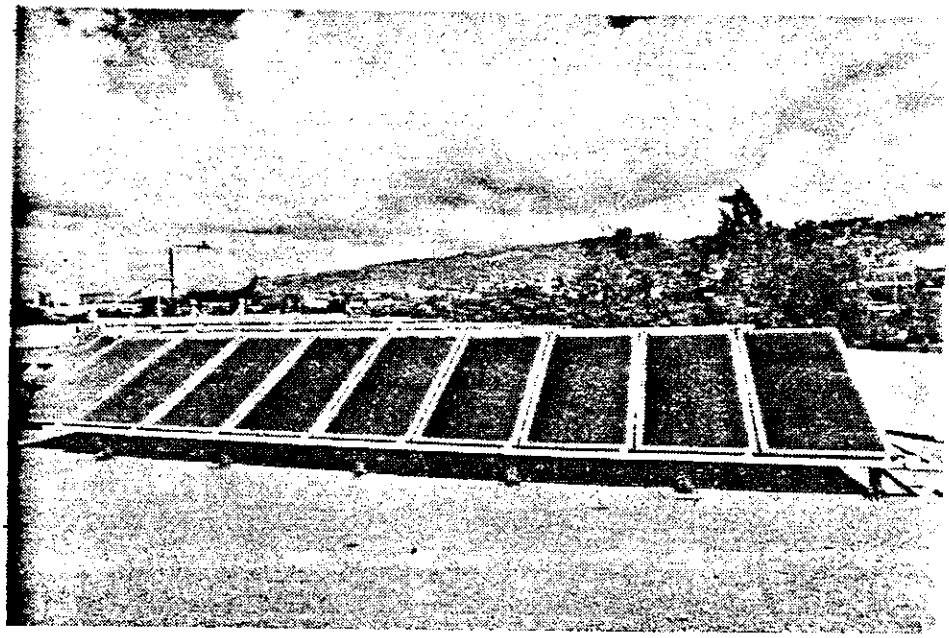
Approximate cost of instrumentation package: ____

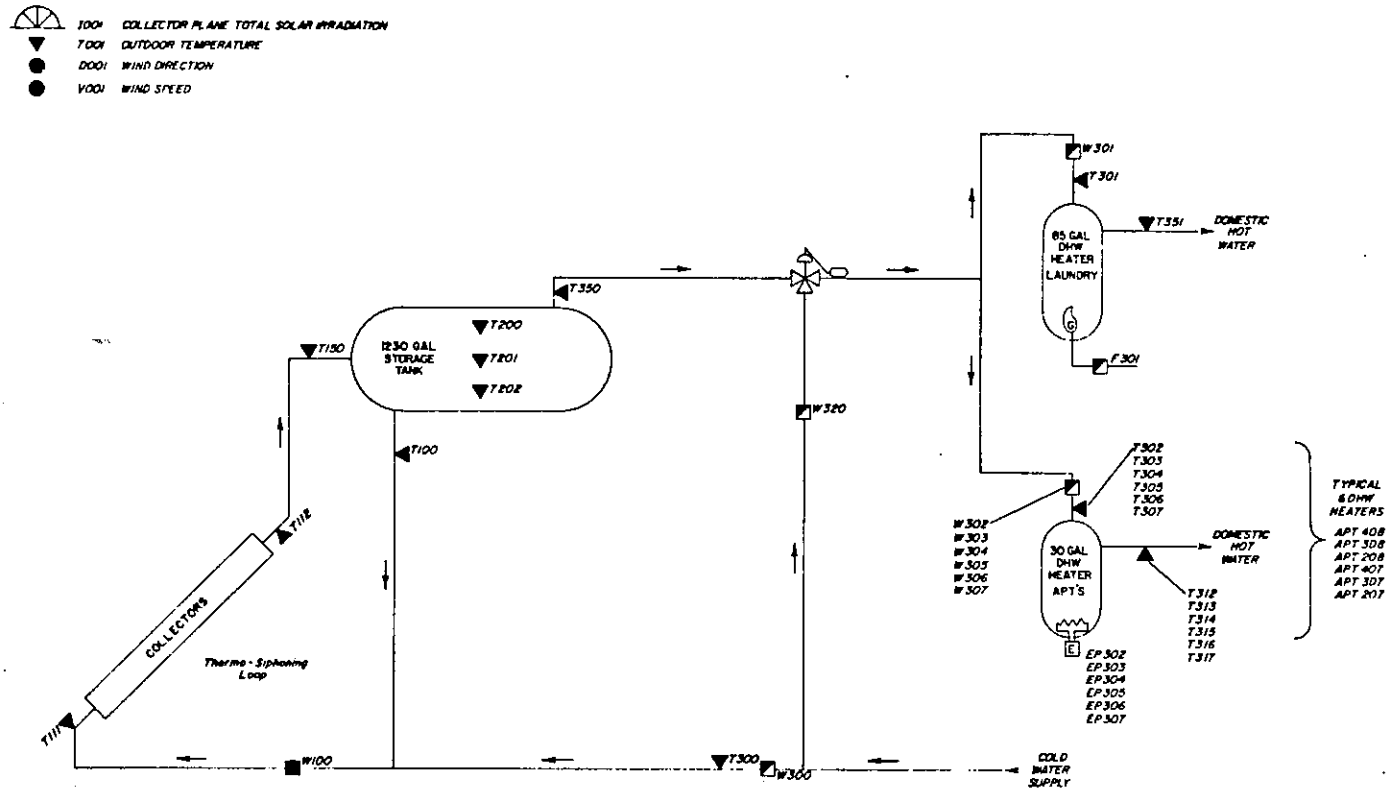
Description of data recording method: Data collected on tape every 320 seconds and sent to the Central Data Processing System daily

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	--	--
	Outdoor Temperature	320 sec	-0.5 F calibrated
	Incident radiation on horizontal surface	--	--
	Incident radiation in plane of collector	320 sec	- 3%
	Relative Humidity	--	--
	Wind Speed	320 sec	- 2%
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	320 sec	± 3% full scale
	Temperature entering & leaving collectors	320 sec	± 0.5°F
	Storage		
	Flow rate inputs to storage	320 sec	± 3% full scale
	Temperature entering & leaving storage	320 sec	± 0.5°F
	Temperature readings in storage(1 or more)	320 sec	± 0.5°F
	Auxiliary energy supplied to storage	--	--
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	320 sec	± 3% full scale
	Temperature entering & leaving subsystems	320 sec	± 0.5°F
	Auxiliary energy supplied to subsystems	320 sec	± 1%
BUILDING SYSTEM	Average DB inside temperature	--	--
	Infiltration load	--	--
	Auxiliary energy	--	--
	Operating energy	--	--
	Total building energy load	--	--
	Internal energy gains	--	--
	Solar gains	--	--
	Solar as a % of total load	--	--
	Thermal capacity of building	--	--

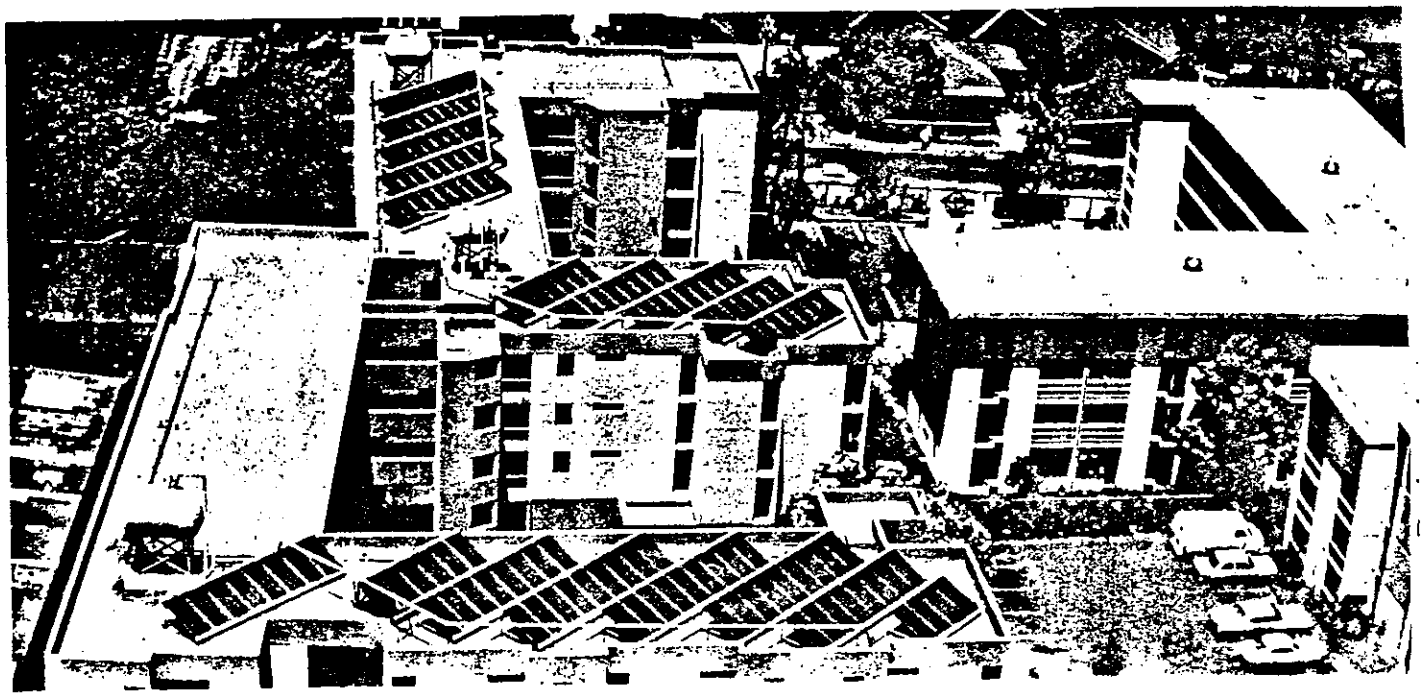
ILLUSTRATION





Hei Wai Wong Solar Energy System Schematic

ILLUSTRATION



IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Matt Cannon

Address: 1827 N. E. 16th Way
Gainesville, Florida 32601

MAIN PARTICIPANTS

	1	2	3
Name Address	Matt Cannon P. O. Box 1454 Gainesville, Florida 32601	Architectural Design Associates, Inc. 502 N. W. 16th Ave. Suite 7 Gainesville, Fl. 32601	Solar Energy Products 1208 N. W. 8th Ave. Gainesville, Florida 32601
Phone	(904) 378-2511	(904) 377-7501	(904) 377-6527
Responsibility	Grantee	Building Designer	Solar System Designer

PROJECT DESCRIPTION

CLIMATE

Latitude 29° Longitude 82° Altitude 155 ft. DD 1,599 Base Temp. 65°F

Sunshine Hours July _____ January _____ Annual _____

Source of data Solar Project Description by NBS and Boeing

Urban _____ Suburban X Rural _____

BUILDING

Floor area 2,426 ft² No. Occupants 6-8

Design Temperature internal w 69 s 70 °F

external w 57 s 83 °F

Mass type unknown location Gainesville, Florida

South Glazing type unknown

area(south glass) 541 ft² % of total glass 10% June

night insulation Cellular rubber/Rubatex shaded 0% December

Heated Volume unknown Ventilation Rate unknown a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Domestic hot water and space heating

Collector Solar Energy Products
type liquid flat plate collectors area(net) 527 ft²

orientation South tilt 34 degrees

Storage type Liquid capacity 1,000 gallons

Auxiliary System type None fuel type Elec. fuel cost 5¢/kwh

PROJECT SCHEDULE

MILESTONES \ DATE						
Construction completion	9/77					
Monitoring period	5/78-present					
Final reports	June 1980					

Report availability — Title: Matt Cannon Solar Energy Perf. Eval. Reports 6/78-present
(available from): U. S. Department of Energy
T. I. C., P. O. Box 62, Oak Ridge, TN 37830

INSTRUMENTATION (existing or anticipated)

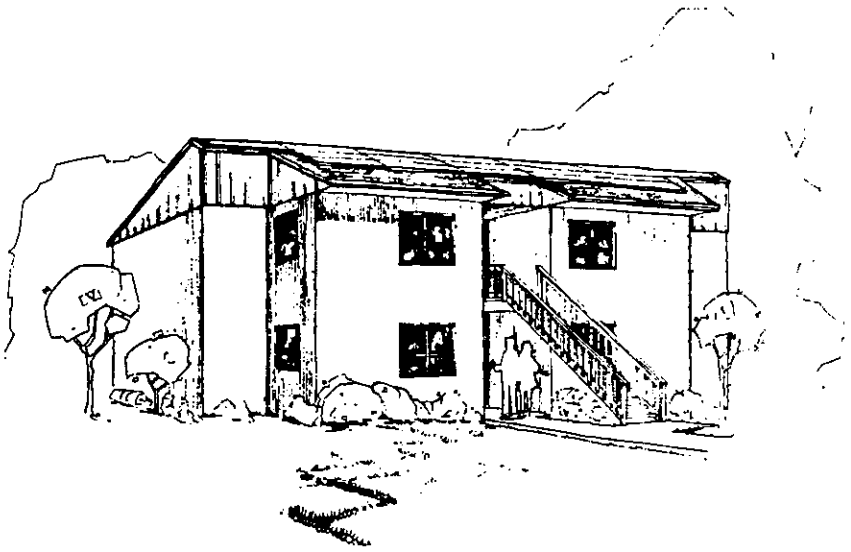
Approximate cost of instrumentation package: unknown

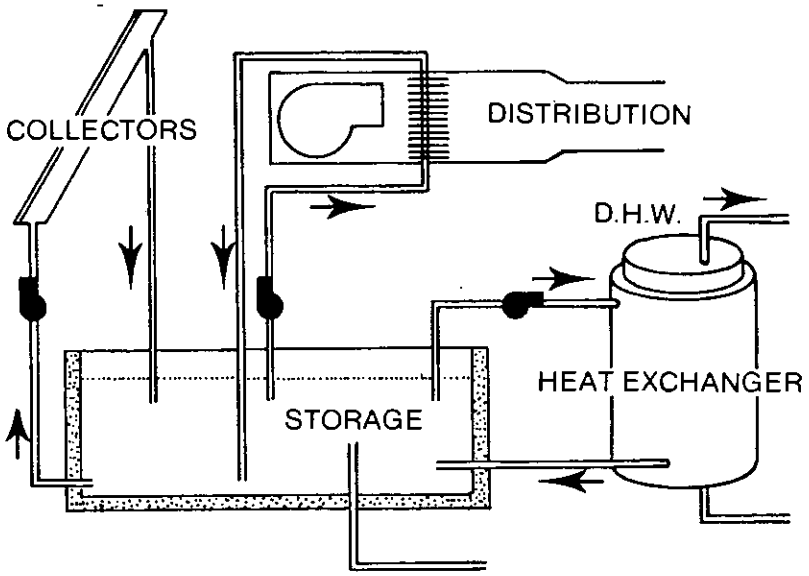
Description of data recording method: Data is collected every 320 seconds on tape and is sent daily to the central processing unit.

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	-	-
	Outdoor Temperature	320 sec.	5%
	Incident radiation on horizontal surface	-	-
	Incident radiation in plane of collector	320 sec.	5%
	Relative Humidity	-	-
	Wind Speed	-	-
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	320 sec.	5%
	Temperature entering & leaving collectors	320 sec.	5%
	Storage		
	Flow rate inputs to storage	320 sec.	5%
	Temperature entering & leaving storage	320 sec.	5%
	Temperature readings in storage(1 or more)	320 sec.	5%
	Auxiliary energy supplied to storage	-	-
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	320 sec.	5%
	Temperature entering & leaving subsystems	320 sec.	5%
	Auxiliary energy supplied to subsystems	320 sec.	5%
BUILDING SYSTEM	Average DB inside temperature	-	-
	Infiltration load	-	-
	Auxiliary energy	-	-
	Operating energy	-	-
	Total building energy load	-	-
	Internal energy gains	-	-
	Solar gains	-	-
	Solar as a % of total load	-	-
	Thermal capacity of building	-	-

ILLUSTRATION





IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

NBS Passive Solar Test Building

Address: National Bureau of Standards, Annex
Gaithersburg, Maryland USA

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Thomas Richtmyer Building 226, Room B104 National Bureau of Standards Washington, DC 20234 301/921-3754		
Responsibility	Instrumentation Engineer		

PROJECT DESCRIPTION

CLIMATE

Latitude 39.1°N Longitude 77.2°W Altitude 400 ft. DD 500Z Base Temp. 65°F

Sunshine Hours July 53,300 January 18,900 Annual 444,000 BTU/hr. ft.^{2}

Source of data TMY, Sterling, VA (Dulles Airport)

Urban ____ Suburban x Rural ____

BUILDING

Floor area 1,460 sq. ft. No. Occupants 0

Design Temperature internal w 65 s 84 °F

external w 14 s 90 °F

Mass type masonry location ____

South Glazing type double

area(south glass) 322 sq. ft. % of total glass 95%

night insulation R5, 50% of glass shaded yes

Heated Volume 12,700 cu. ft. Ventilation Rate estimated - 1 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) heating (passive only)

Collector type direct gain, vented trombe wall area(net) 322 sq. ft.

orientation true south tilt 90° (vertical)

Storage type storage wall, slab-on-grade floor internal CMU wall capacity approx. 200,000 BTU @ 20° F swing

Auxiliary System type Fan Coil: Elec. resist., central chiller fuel type elec. fuel cost 5¢/KW hr.

PROJECT SCHEDULE

MILESTONES \ DATE	11/15/80	11/80	10/82	6/81	6/82	
Construction completion	X					
Monitoring period		⊢	———	⊣		
Final reports				X	X	

Report availability — Title: ---

(available from)

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: $50,000

Description of data recording method: Minicomputer (HP2100), magnetic tape

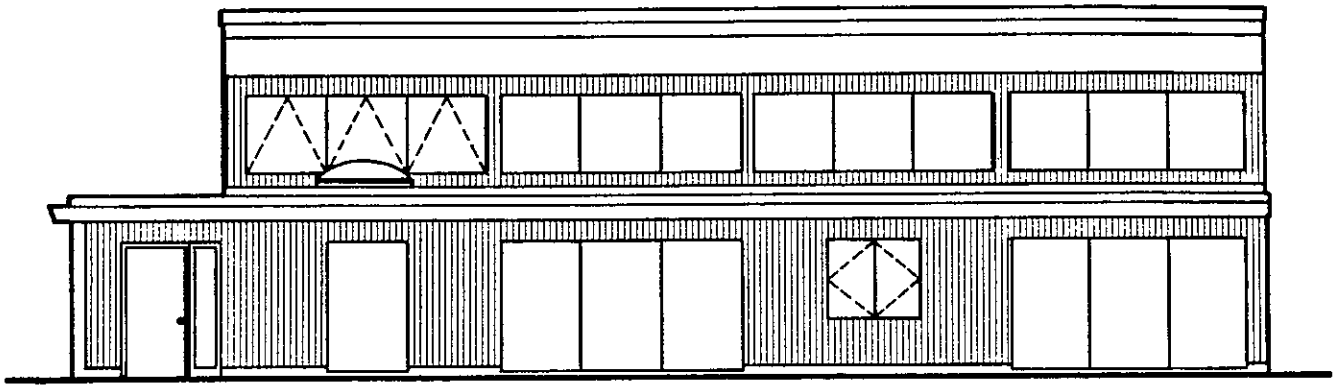
DATA RECORDED

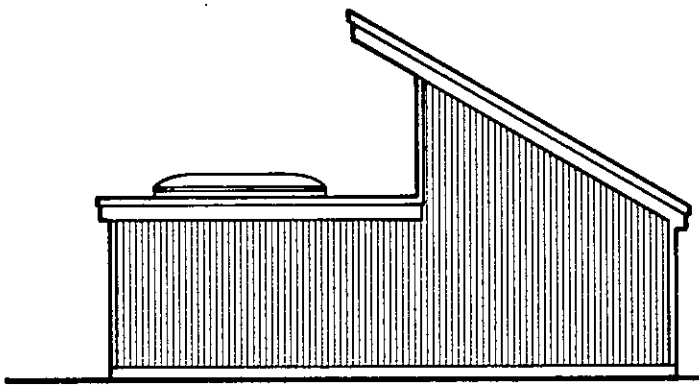
		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	---	---
	Outdoor Temperature	5 min	± 1°F
	Incident radiation on horizontal surface		Class I WMO
	Incident radiation in plane of collector		"
	Relative Humidity		± 40
	Wind Speed & Direction		± 5% of reading
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	several times	?
	Temperature entering & leaving collectors	5 min	± 10F
	Storage		
	Flow rate inputs to storage	---	---
	Temperature entering & leaving storage	---	---
	Temperature readings in storage(1 or more)	5 min	± 1°F
	Auxiliary energy supplied to storage	---	---
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	cont.	?
	Temperature entering & leaving subsystems	5 min	± 1°F
	Auxiliary energy supplied to subsystems	5 min	± 2% of reading
BUILDING SYSTEM	Average DB inside temperature	5 min	± 2°F
	Infiltration load	winter/summer	?
	Auxiliary energy	cont.	± 2% of reading
	Operating energy	cont.	"
	Total building energy load	winter/summer	?
	Internal energy gains	5 min	± 2% of reading
	Solar gains	5 min	?
	Solar as a % of total load	monthly	?
	Thermal capacity of building	monthly	?

ILLUSTRATION

NBS PASSIVE TEST BUILDING

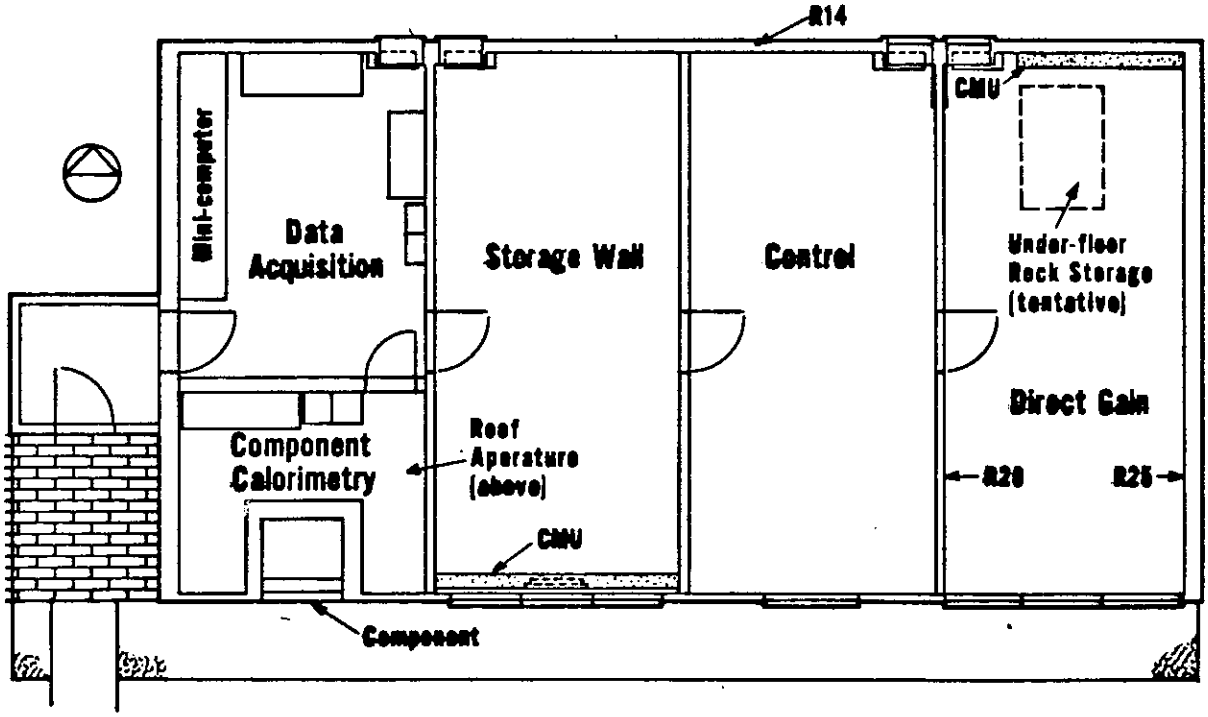
South Elevation





East Elevation

NBS PASSIVE TEST BUILDING



IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Saddle Hill Trust Lot 36

Address: 21 Saddle Hill Road
Medway, Massachusetts 20253

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Don Huber Boeing Aerospace Company P.O. Box 3999 MS-8612 Seattle, Wash. 98123 206-773-0640	Warren Mackensen Sippican Solar Systems 14 Ichabod Lane Marion, Mass. 02738 671-748-2810	Sanford Kaplan 10 Kearney Road Needham, Mass. 02194 617-443-3400
Responsibility	Instrumentation Engineer	Designer	Contractor

PROJECT DESCRIPTION

CLIMATE

Latitude 43n Longitude 71w Altitude 200 ft DD 5791 Base Temp. 65°F

Sunshine Hours July -- January -- Annual --

Source of data NOAA local climatological data

Urban ____ Suburban X Rural ____

BUILDING

Floor area 1944 ft² No. Occupants 4

Design Temperature internal w -- s -- ° --

external w -- s -- ° --

Mass type unknown location Medway, Mass

South Glazing type unknown

area(south glass) unknown % of total glass unknown

night insulation unknown shaded unknown

Heated Volume unknown Ventilation Rate unknown a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Heating and domestic hot water

Collector type Daystor #2001, flat plate liquid area(net) 393 ft²

orientation south tilt 58°

Storage type water capacity 750 gallon

Auxiliary System type heating/oil furnace fuel type #2 oil fuel cost unknown

PROJECT SCHEDULE

MILESTONES \ DATE						
Construction completion	1977					
Monitoring period	3/79 to present					
Final reports	3/79 to present					

Report availability — Title: Monthly Performance Report (Saddle Hill Trust (36))
(available from): Technical Information Center
P.O. Box 62, Oak Ridge, TN 37830

INSTRUMENTATION (existing or anticipated)

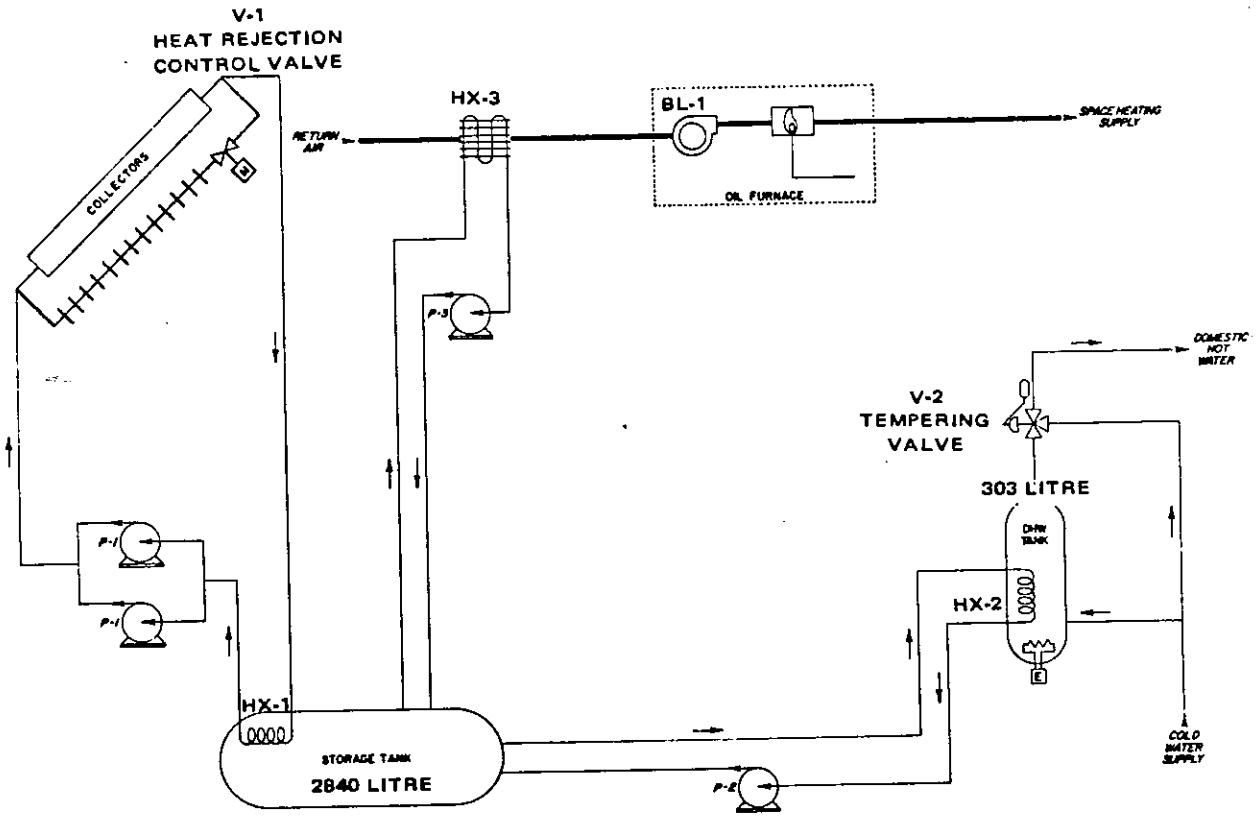
Approximate cost of instrumentation package: ____

Description of data recording method: Data collected on tape every 320 seconds, and sent to the Central Data Processing System daily

DATA RECORDED

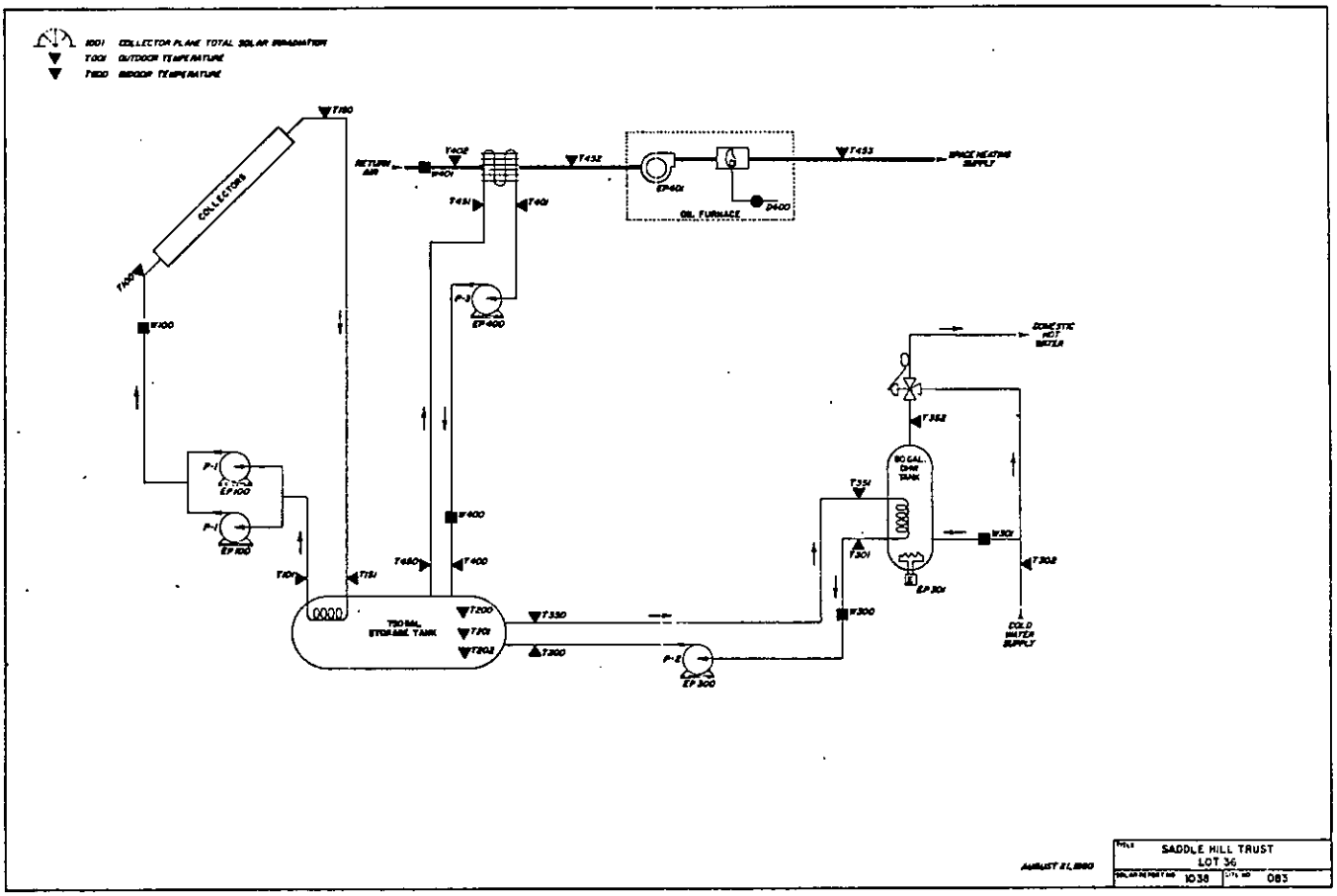
		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	--	--
	Outdoor Temperature	320 sec	± 0.5°F calibrated
	Incident radiation on horizontal surface	--	--
	Incident radiation in plane of collector	32 sec	± 3%
	Relative Humidity	--	--
	Wind Speed	320 sec	± 2%
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	320 sec	± 3% full scale
	Temperature entering & leaving collectors	320 sec	± 0.5°F
	Storage		
	Flow rate inputs to storage	320 sec	± 3% full scale
	Temperature entering & leaving storage	320 sec	± -.5°F
	Temperature readings in storage(1 or more)	320 sec	± 0.5°F
	Auxiliary energy supplied to storage	--	--
	Space heat, Space cooling, Hot water Subsystems		
	Flow rates entering subsystems	320 sec	± 3% full scale
	Temperature entering & leaving subsystems	320 sec	± 0.5°F
	Auxiliary energy supplied to subsystems	320 sec	± 1%
BUILDING SYSTEM	Average DB inside temperature	320 sec	± 0.5°F
	Infiltration load	--	--
	Auxiliary energy	320 sec	± 1%
	Operating energy	320 sec	± 1%
	Total building energy load	--	--
	Internal energy gains	--	--
	Solar gains	--	--
	Solar as a % of total load	--	--
	Thermal capacity of building	--	--

ILLUSTRATION



Saddle Hill Trust Lot 36 Solar Energy System Schematic

ILLUSTRATION



IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Saddle Hill Trust Lot 77

Address: 22 Green Walley Road
Medway, Massachusetts 20253

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Don Huber Boeing Aerospace Company P.O. Box 3999 MS-8612 Seattle, Wash. 98124 206-773-0640	Warren Mackensen Sippican Solar Systems 14 Ichabod Lane Marion, Mass. 02738 617-748-2810	Sanford Kaplan 10 Kearney Road Needham, Mass. 02194 617-443-3400
Responsibility	Instrumentation Engineer	Designer	Contractor

PROJECT DESCRIPTION

CLIMATE

Latitude 42n Longitude 71w Altitude 200 ft DD 5791 Base Temp. 65°F

Sunshine Hours July _____ January _____ Annual _____

Source of data NOAA local climatological data

Urban _____ Suburban X Rural _____

BUILDING

Floor area 1696 ft² No. Occupants 4

Design Temperature internal w -- s -- °--

external w -- s -- °--

Mass type unknown location Medway, Mass.

South Glazing type unknown

area(south glass) unknown % of total glass unknown

night insulation unknown shaded unknown

Heated Volume unknown Ventilation Rate unknown a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Domestic hot water

Collector type Solaron air, flat-plate area(net) 78 (gross)

orientation south tilt 38°

Storage type water pre-heat tank capacity 120 gal

Auxiliary System type gas heater fuel type gas fuel cost unknown

PROJECT SCHEDULE

MILESTONES \ DATE						
Construction completion	1977					
Monitoring period	1/79 to present					
Final reports	1/79 to present (except 2/79)					

Report availability — Title (available from): Monthly Performance Report (Saddle Hill Trust (77)
Technical Information Center
P.O. Box 62, Oak Ridge, TN 37830

INSTRUMENTATION (existing or anticipated)

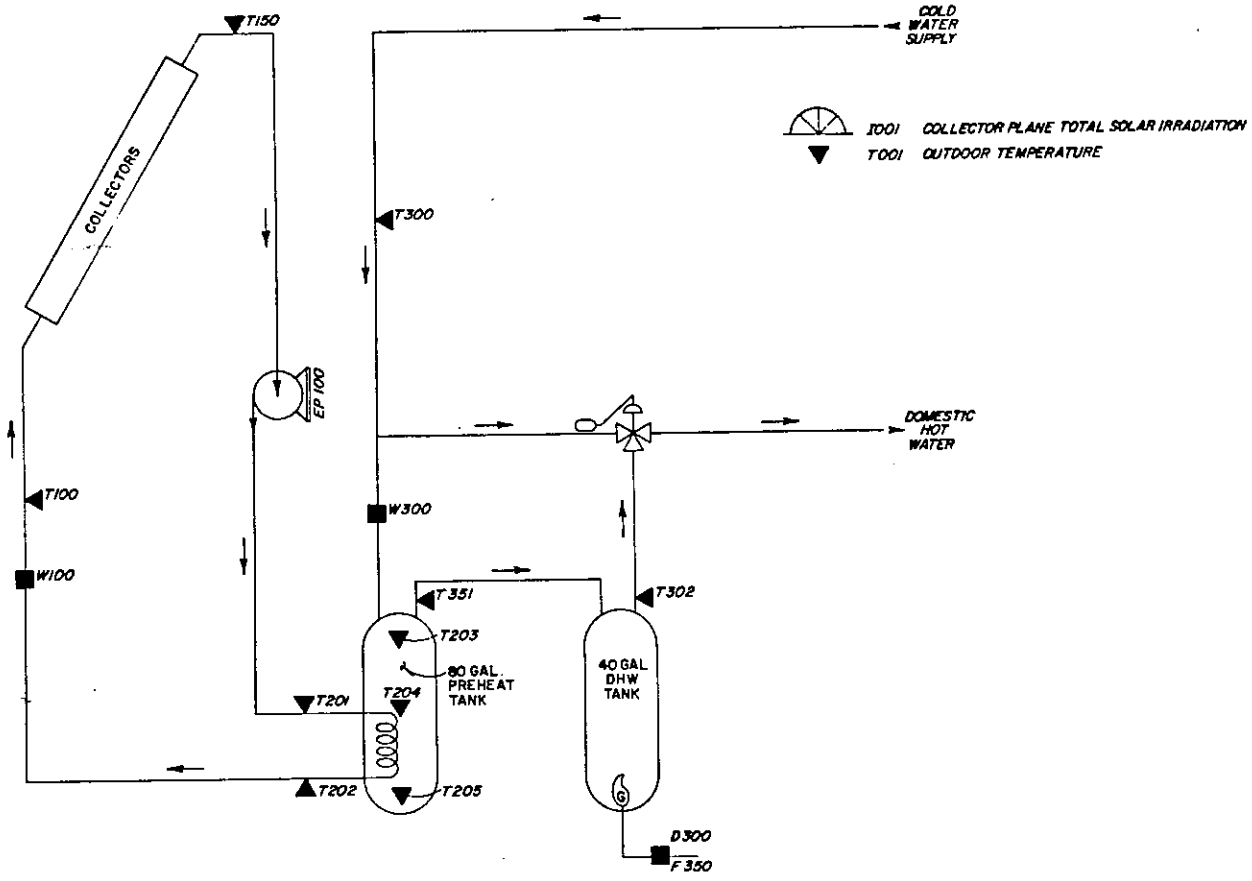
Approximate cost of instrumentation package _____

Description of data recording method: Data collected on tape every 320 seconds, and sent to the Central Processing System daily

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	--	--
	Outdoor Temperature	320 sec	± 0.5°F calibrated
	Incident radiation on horizontal surface	--	--
	Incident radiation in plane of collector	320 sec	± 3%
	Relative Humidity	--	--
	Wind Speed	320 sec	± 2%
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	320 sec	± 3% full scale
	Temperature entering & leaving collectors	320 sec	± 0.5°F
	Storage		
	Flow rate inputs to storage	320 sec	± 3% full scale
	Temperature entering & leaving storage	320 sec	± 0.5°F
	Temperature readings in storage(1 or more)	320 sec	± 0.5°F
	Auxiliary energy supplied to storage	--	--
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	320 sec	± 3% full scale
	Temperature entering & leaving subsystems	320 sec	± 0.5° F
	Auxiliary energy supplied to subsystems	320 sec	± 1%
BUILDING SYSTEM	Average DB inside temperature	320 sec	± 0.5°F
	Infiltration load	320 sec	± 0.5°F
	Auxiliary energy	320 sec	± 0.5°F
	Operating energy	320 sec	± 0.5°F
	Total building energy load	320 sec	± 0.5°F
	Internal energy gains	320 sec	± 0.5°F
	Solar gains	320 sec	± 0.5°F
	Solar as a % of total load	320 sec	± 0.5°F
	Thermal capacity of building	320 sec	± 0.5°F

ILLUSTRATION



Saddle Hill Trust Lot 73 Solar Energy System Schematic

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Sir Galahad Company

Address: 3929 Forest Glen Road
Virginia Beach, Virginia 23452

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Solar One Ltd. 2644 Barrett Street Virginia Beach, Virginia 23452 (804) 340-7262		
Responsibility	Designer, Solar Contractor		

PROJECT DESCRIPTION

CLIMATE

Latitude 37°N Longitude 76°W Altitude 26 ft. DD 3,488 Base Temp. 65°F

Sunshine Hours July 65% January 57% Annual 63%

Source of data NOAA Local Climatological Data for Norfolk, Va.

Urban ____ Suburban X Rural ____

BUILDING

Floor area 1,604 ft² No. Occupants 1

Design Temperature internal w 68 s ____ °F

external w 23 s ____ °F

Mass type unknown location Virginia

South Glazing type unknown

area(south glass) 80 square feet % of total glass 50%

night insulation none shaded 0%

Heated Volume approx. 13,000 cubic feet Ventilation Rate 1.3 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Heating and Domestic Hot Water

Collector type ____ area(net) 640 ft² (absorber)

orientation South tilt 45 degrees

Storage type Steel capacity 1,500 gallons

Auxiliary System type Heat pump, elec. DHW aux. fuel type elec. fuel cost 6.5¢/kwh

PROJECT SCHEDULE

MILESTONES \ DATE						
Construction completion	11/77					
Monitoring period	2/78-present					
Final reports	Monthly Reports Dec. 1979-Sept. 1980					

Report availability — Title: Sir Galahad Solar Energy System Perf. Eval. 11/79-4/80
(available from): U. S. Department of Energy
T. I. C., P. O. Box 62, Oak Ridge, TN 37830

INSTRUMENTATION (existing or anticipated)

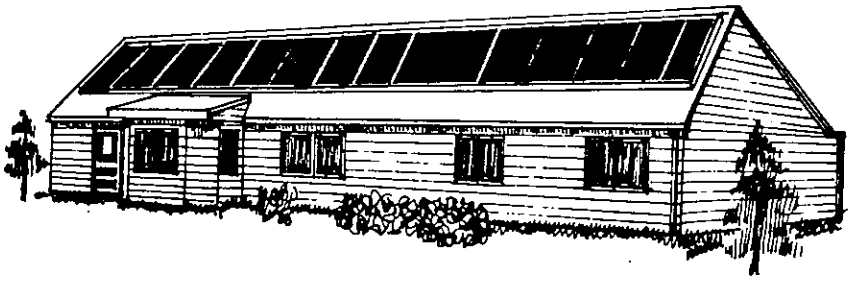
Approximate cost of instrumentation package: $18,000

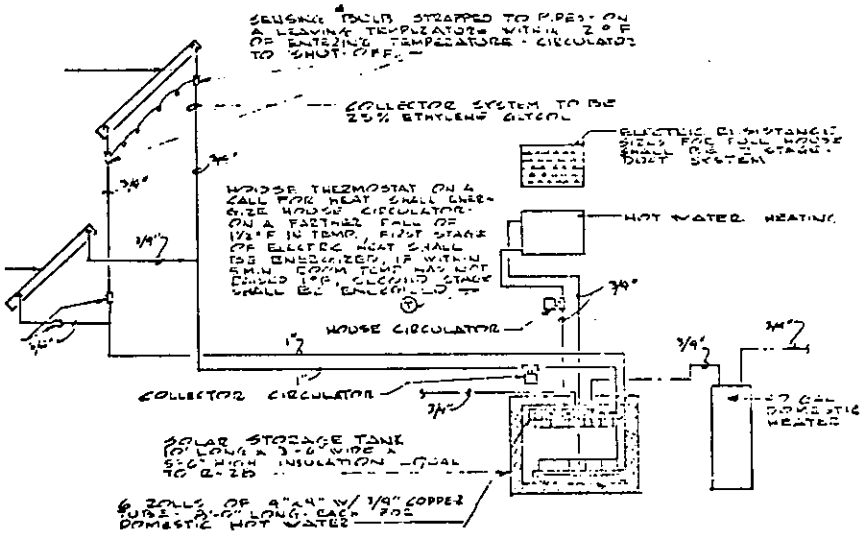
Description of data recording method: Data collected on tape every 320 seconds, sent to central computer every day.

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	-	-
	Outdoor Temperature	320 sec.	.5°F
	Incident radiation on horizontal surface	-	-
	Incident radiation in plane of collector	320 sec.	.5°F
	Relative Humidity	-	-
	Wind Speed	-	-
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	320 sec.	.2 gpm
	Temperature entering & leaving collectors	320 sec.	.5°F
	Storage		
	Flow rate inputs to storage	320 sec.	.2 gpm
	Temperature entering & leaving storage	320 sec.	.5°F
	Temperature readings in storage(1 or more)	320 sec.	.5°F
	Auxiliary energy supplied to storage	320 sec.	.5°F
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	320 sec.	.2 gpm
	Temperature entering & leaving subsystems	320 sec.	.5°F
	Auxiliary energy supplied to subsystems	320 sec.	.01 kw
BUILDING SYSTEM	Average DB inside temperature	320 sec.	.5°F
	Infiltration load	-	-
	Auxiliary energy	320 sec.	.5°F
	Operating energy	320 sec.	.5°F
	Total building energy load	-	-
	Internal energy gains	-	-
	Solar gains	-	-
	Solar as a % of total load	-	-
	Thermal capacity of building	-	-

ILLUSTRATION





SOLAR COLLECTOR PIPING DIAGRAM

NO SCALE

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Solar House I

Address: Solar Energy Applications Lab.
Colorado State University
Ft. Collins, Colorado 80523

MAIN PARTICIPANTS

	1 Director	2 IEA Correspondent	3
Name	Dr. George O. G. Lof	Dr. William S. Duff	
Address	Solar Energy Applications Lab. Colorado State University Ft. Collins, Colorado 80523	Solar Energy Applications Lab. Colorado State University Ft. Collins, Colorado 80523	
Phone			
Responsibility			

PROJECT DESCRIPTION

Comparative performance of two types of evacuated tube collectors in a residential heating & cooling system.

CLIMATE

Latitude 40.6° N Longitude 105.1° W Altitude 1585°M DD 3600° C Base Temp. 18.3° C

Sunshine Hours July 321 January 207 Annual 3033

Source of data On site data acquistion

Urban ____ Suburban ____ Rural ____

BUILDING

Floor area 128.5 M^2 No. Occupants used as offices

Design Temperature internal w 22.2 s ____ °C

external w -23 s ____ °C

Mass type Low (wood frame) location Foothills of Eastern slopes of the Rockies.

South Glazing type Vert. triple glazing

area(south glass) 10 M^2 % of total glass 35%

night insulation none shaded 45°

Heated Volume ____ Ventilation Rate ____ a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Heating/Cooling DHW

Collector type Flat plate - liquid
Evac. tube (corning) (phillips) July 78 area(net) 71.3 M^2 75.2 M^2

orientation South tilt 45°

Storage type E.T. Water (galv. steel) 4277 l
F.P. Water (galv. steel) capacity 4277 l

Auxiliary System type Boiler 23.5kw output (rated) fuel type Gas fuel cost ____

PROJECT SCHEDULE

MILESTONES \ DATE	1975	1976	1977	1978	1979	1980
Construction completion						
Monitoring period						
Final reports						

Report availability — Title (available from): See "Project Description"
N.T.I.S. U.S. Dept. of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: _____

Description of data recording method: Analog and pulse accum. - Doric 220 Data Logger
Tape Recorder - Minicomputer for real time monitoring.

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	calculated	-
	Outdoor Temperature	10 min.	.4°C
	Incident radiation on horizontal surface	read & reset @ 10 min.	1.5%R + .5%
	Incident radiation in plane of collector	read & reset @ 10 min.	1.5%R + .5%
	Relative Humidity	10 min.	.5%F
	Wind Speed	10 min.	.07 m/s
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	read & reset @ 10 min.	1.0%R + .02 n/m^2
	Temperature entering & leaving collectors	read & reset @ 10 min.	.4°C
	Storage		
	Flow rate inputs to storage	read & reset @ 10 min.	1.0%R + .02 n/m^2
	Temperature entering & leaving storage	read & reset @ 10 min.	.4°C
	Temperature readings in storage(1 or more)	10 min.	.4°C
	Auxiliary energy supplied to storage	read & reset @ 10 min.	025%R + 025%F
	Space heat, Space cooling, Hot water Subsystems		
	Flow rates entering subsystems	read & reset @ 10 min.	1.0%R + .02 n/m^2
	Temperature entering & leaving subsystems	read & reset @ 10 min.	.4°C
	Auxiliary energy supplied to subsystems	read & reset @ 10 min.	025%R + 025%F
BUILDING SYSTEM	Average DB inside temperature	10 min.	.4°C
	Infiltration load	calculated	-
	Auxiliary energy	read & reset @ 10 min.	.25%R + .25%F
	Operating energy	read & reset @ 10 min.	.25%R + .25%F
	Total building energy load	calculated	-
	Internal energy gains	calculated	-
	Solar gains	1 calculated	
	Solar as a % of total load	calculated	-
	Thermal capacity of building	-	-

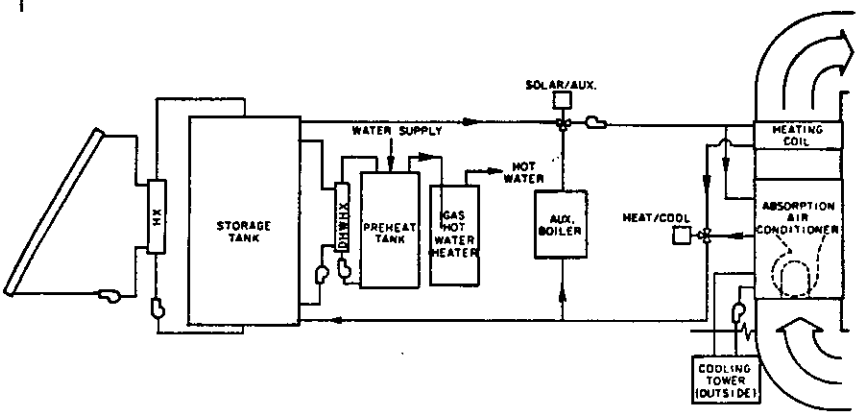


Figure 2-4. CSU Solar House I Equipment Diagram, July 1974 to May 1976

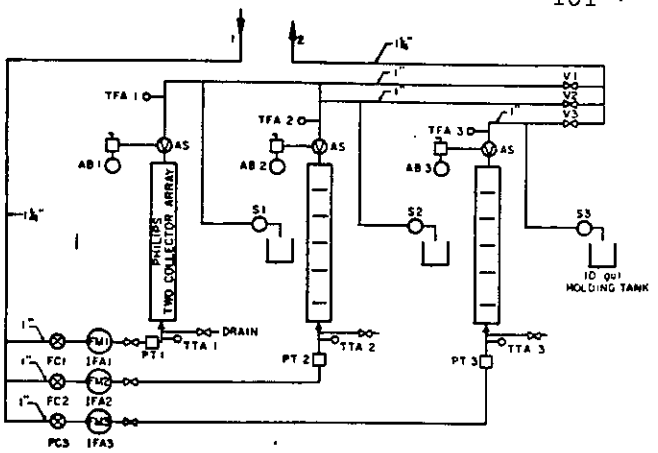
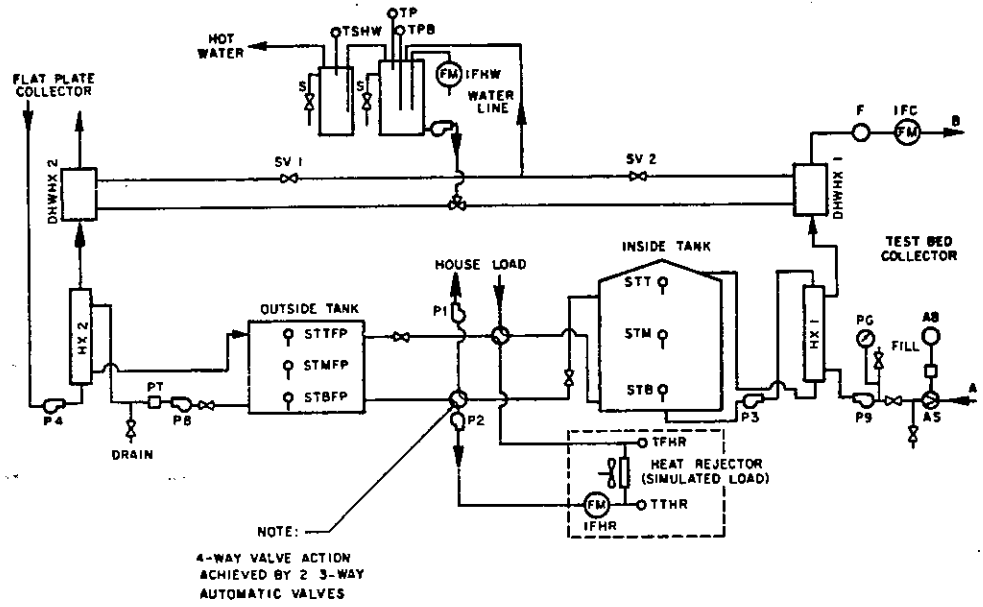


Figure 2-14. Philips Collector Piping Detail, May 1978 to October 1978



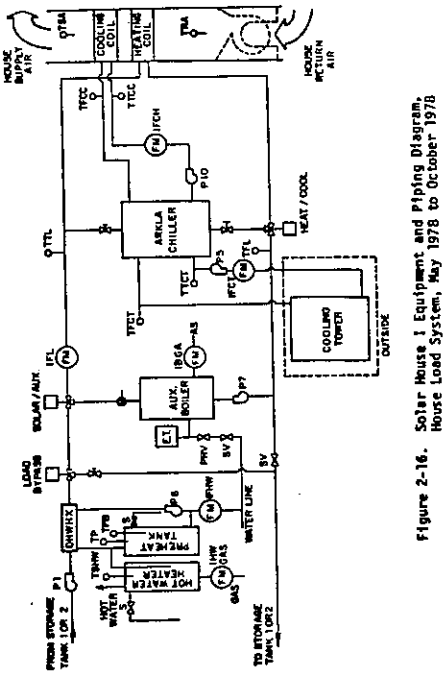
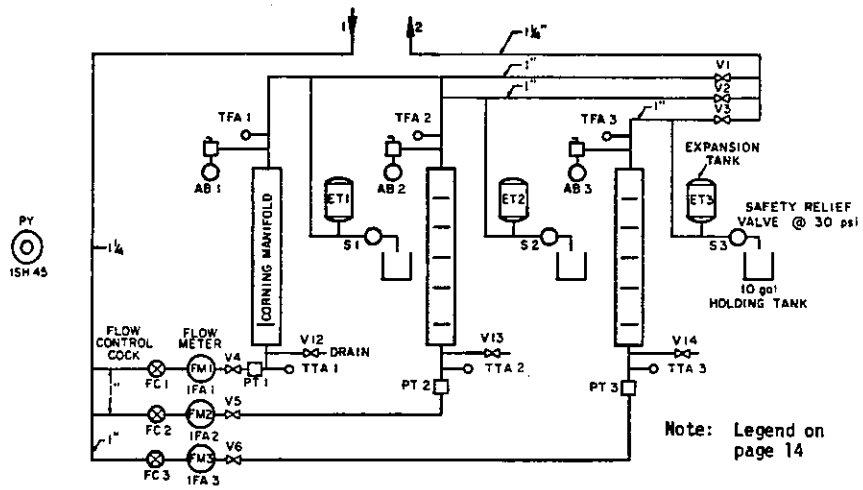


Figure 2-16. Solar House I Equipment and Piping Diagram, House Load System, May 1978 to October 1978

Figure 2-9. CSU Solar House I Solar Collection and Storage System December 1976 to April 1978



Note: Legend on page 14

Figure 2-10. Corning Collector Piping Detail, December 1976 to June 1978

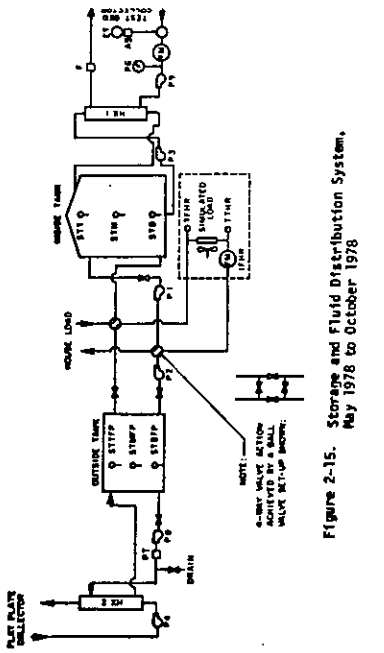


Figure 2-15. Storage and Fluid Distribution System, May 1978 to October 1978

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Solar House II

Address: Solar Energy Applications Laboratory
Colorado State University
Fort Collins, CO 80523

MAIN PARTICIPANTS

	1 DIRECTOR	2 IEZ CORRESPONDENT	3
Name	Susumu Karaki	William S. Duff	
Address	(Above)	(Above)	
Phone			
Responsibility			

PROJECT DESCRIPTION

CLIMATE

Latitude 40.6°N Longitude 105.1°W Altitude 1585 M DD 3600°C Base Temp. 18.3°C

Sunshine Hours July _____ January 924 lang/day Annual _____

Source of data on site data acquisition

Urban _____ Suburban x Rural _____

BUILDING

Floor area 128.5 M^2 No. Occupants 0 (Researchers)

Design Temperature internal w _____ s _____ °

external w _____ s _____ °

Mass type low (wood frame) location _____

South Glazing type vertical double glass

area(south glass) 10 M^2 % of total glass 35%

night insulation None shaded 1.8 M overhang

Heated Volume _____ Ventilation Rate _____ a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) space heating, DHW

Collector type Solaron Series 3000 area(net) 57.9 M^2

orientation 180° tilt 45°

Storage type pebble bed (wood container) capacity 10.3 M^3

Auxiliary System type heat pump (3 ton carrier) Air to Air fuel type Elec. fuel cost _____

DHW - 300 liter (A. O. Smith) Elec.

PROJECT SCHEDULE

MILESTONES \ DATE	1977	1978	1979	1980		
Construction completion	———	———				
Monitoring period			———			
Final reports				* Annual Report		

Report availability — Title (available from): Performance eval. S.O.A. Solar Air-Heating System with Auxiliary Heat Pump Rpt. No. COO/30122-4

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: Unknown (very expensive)

Description of data recording method: Doric scientific mod. 200 Digitrand - scanner, multiflexer, analog to digital, convertor, printer - Kennedy tape deck and wang desk top computer.

DATA RECORDED

		Frequency of data recording		Accuracy of instrument
METEOROLOICAL	Degree Days			
	Outdoor Temperature	300 sec		± .4°C
	Incident radiation on horizontal surface	---		---
	Incident radiation in plane of collector	300 sec	R-O-2800W/M^2	1.5%R ±.5%
	Relative Humidity	300 sec		.5% F
	Wind Speed	300 sec		± .07 M/S
	Wind Direction			± 2°
SOLAR SYSTEM	Collectors			
	Flow rate entering collectors	300 sec	R=1-20 M/S	± 1.0%R + .02 N/M^2
	Temperature entering & leaving collectors	300 sec		± .4°C
	Storage			
	Flow rate inputs to storage	300 sec		± 1.0%R + .02 N/M^2
	Temperature entering & leaving storage	300 sec		± .4°C
	Temperature readings in storage(1 or more)	300 sec		± .4°C
	Auxiliary energy supplied to storage	---		---
	Space heat, Space cooling, Hot water Subsystems			
	Flow rates entering subsystems	300 sec		± 1.0%R + .02 N/M^2
	Temperature entering & leaving subsystems	300 sec		± .4°C
	Auxiliary energy supplied to subsystems	300 sec		
BUILDING SYSTEM	Average DB inside temperature	300 sec		± .4°C
	Infiltration load	---		---
	Auxiliary energy	300 sec		± .75%R + .25%F
	Operating energy	300 sec		± .75%R + .25%F
	Total building energy load	---		---
	Internal energy gains	---		---
	Solar gains	calc.		calc.
	Solar as a % of total load	calc.		calc.
	Thermal capacity of building	---		---

ILLUSTRATION

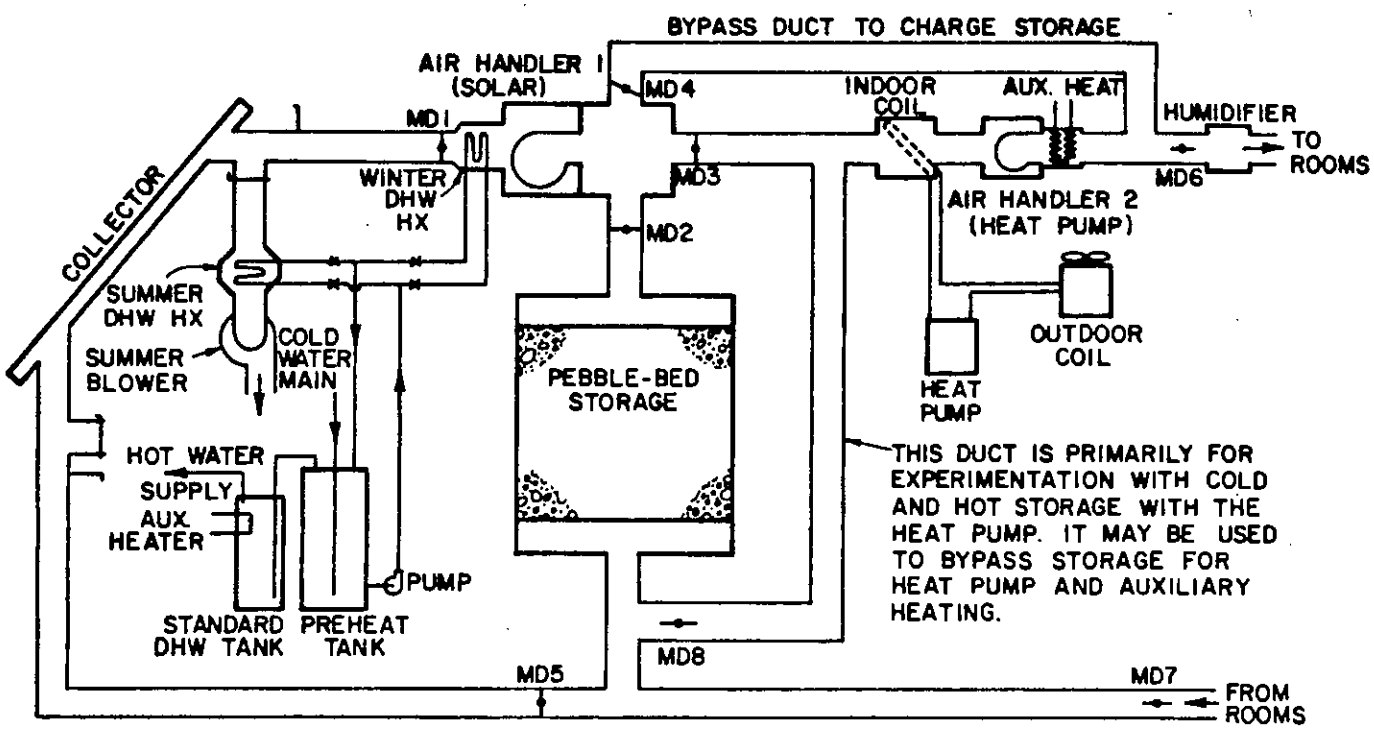


Figure 2-7. Schematic Diagram of Solar Heating and Heat Pump Auxiliary System in CSU Solar House II

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

~~Stewart-Teele-Mitchell~~
Address: 1 Northwood Drive
Ballston Spa, NY 12020

MAIN PARTICIPANTS

	1	2	3
Name	Max Gertsch	Brooks Teele	Carl Schmidtke
Address	Boeing Aerospace Company P.O. Box 3999 Seattle, WA 98124	Stewart-Teele-Mitchell Construction Company Plank Road, Box 374, Rt.146 Clifton Park, NY 12065	1 Northwood Drive Ballston Spa, NY 12020
Phone	206-773-0640	518-371-2622	518-585-7413 home 518-885-6436 work
Responsibility	Field Representative	Site Contractor	Home Owner

PROJECT DESCRIPTION

CLIMATE

Latitude 45° Longitude 74° Altitude 278 ft. DD 6785 Base Temp. 65°F

Sunshine Hours July -- January -- Annual --

Source of data NOAA local climatological data

Urban ____ Suburban X Rural ____

BUILDING

Floor area 1900 ft² No. Occupants 4

Design Temperature internal w ____ s ____ °

external w 0 s 88 ° F

Mass type unknown location Ballston Spa, NY

South Glazing type --

area(south glass) -- % of total glass unknown

night insulation -- shaded --

Heated Volume -- Ventilation Rate -- a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) Space heating and domestic hot water

Collector type Lennox flat plate area(net) 432 ft²

orientation south tilt 45°

Storage type liquid (water) capacity 1000 gal.

Auxiliary System type gas boiler/electric hot water heater fuel type gas/elec. fuel cost unknown

PROJECT SCHEDULE

MILESTONES \ DATE	1978	1979	1980	June 1979		
Construction completion	Unknown					
Monitoring period	Apr-Dec	Jan-Dec	Jan-Aug	1978-79		
Final reports	Apr-Dec	Jan-May	Apr,Jun-Aug	Seasonal 6/79		

Report availability (available from)
Title: Monthly Performance Report (Stewart-Teele-Mitchell)
Technical Information
P.O. Box 62, Oak Ridge, TN 37830

INSTRUMENTATION (existing or anticipated)

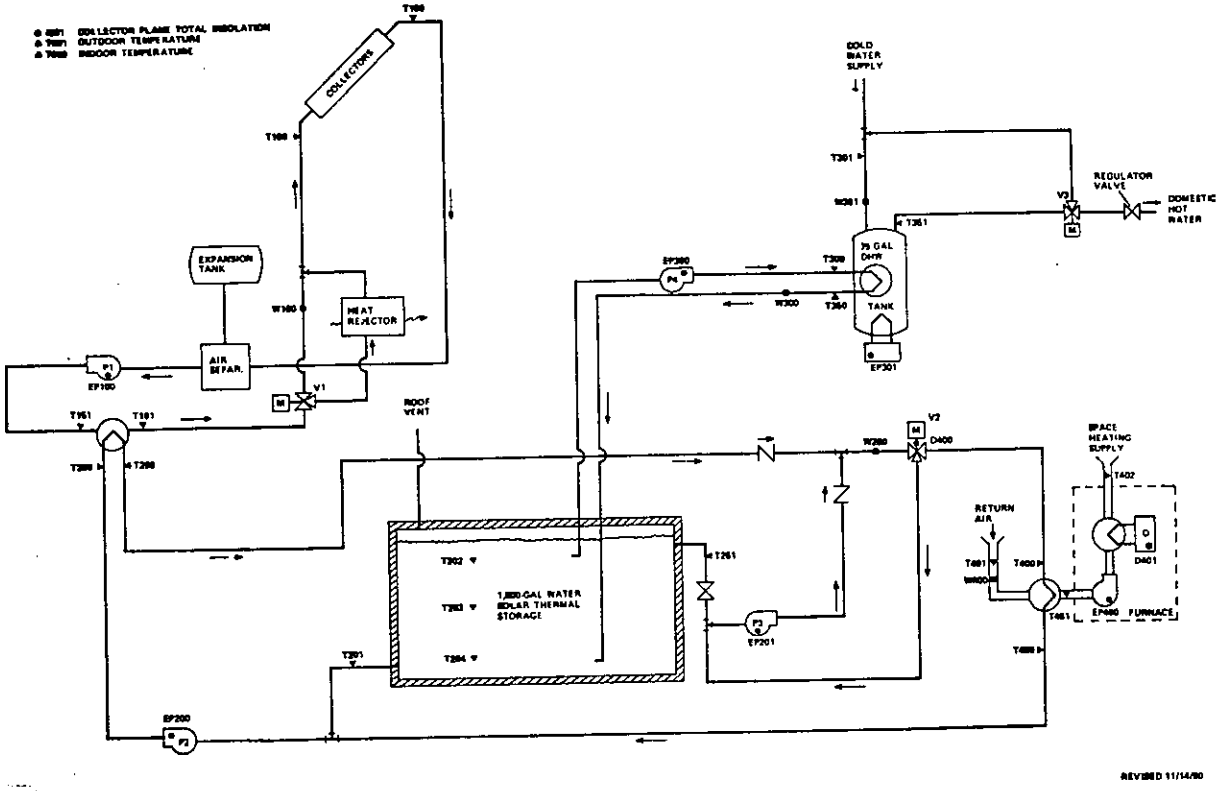
Approximate cost of instrumentation package: $800

Description of data recording method: Data collected on tape every 320 seconds, and sent to the central data processing system daily.

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	--	--
	Outdoor Temperature	320 sec.	± 5°F
	Incident radiation on horizontal surface	--	--
	Incident radiation in plane of collector	320 sec	± 5°F
	Relative Humidity	--	--
	Wind Speed	--	--
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	~~320 sec~~	± 3% full scale
	Temperature entering & leaving collectors	320 sec	± 0.5°F
	Storage		
	Flow rate inputs to storage	320 sec	± 3%
	Temperature entering & leaving storage	320 sec	± 0.5°F
	Temperature readings in storage(1 or more)	3 at 320 sec	± 0.5°F
	Auxiliary energy supplied to storage	--	--
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	320 sec	± 3%
	Temperature entering & leaving subsystems	320 sec	± 0.5°F
	Auxiliary energy supplied to subsystems	320 sec	± 1%
BUILDING SYSTEM	Average DB inside temperature	--	--
	Infiltration load	--	--
	Auxiliary energy	--	--
	Operating energy	320 sec	± 1%
	Total building energy load	--	--
	Internal energy gains	--	--
	Solar gains	--	--
	Solar as a % of total load	--	--
	Thermal capacity of building	--	--

ILLUSTRATION



Stewart-Teele-Mitchell Solar Energy System Schematic

WEST GERMANY

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

"Energy Conservation and Utilisation of Solar Energy in Buildings"

Address

Philips GmbH Forschungslaboratorium Aachen
Weisshausstrasse, D-5100 Aachen / West Germany

MAIN PARTICIPANTS

	1	2	3
Name	Dr. H. Hörster	Dr. G. Bergmann	
Address	Philips Forschungslaboratorium Weisshausstrasse D-5100 Aachen West Germany	Dr. R. Bruno Dr. W. Hermann Dr. R. Kersten K. Klinkenberg B. Steinmüller	
Phone	0241 - 62071		
Responsibility	Project leader		

PROJECT DESCRIPTION

CLIMATE

Latitude 50.76° Longitude 6.09° Altitude 195 m DD 3445 Base Temp. 20°C

Sunshine Hours July 189 January 50 Annual 1510

Source of data Meteorological Service Aachen

Urban X Suburban ____ Rural ____

BUILDING

Floor area 116 m^2 No. Occupants 4 (simulated)

Design Temperature internal w ____ s 20 °C

external w ____ s - 12 °C

Mass type ____ location Aachen

South Glazing type double glazed, gold layer k = 1.9 W/m^2K

area(south glass) 4.6 m^2 % of total glass 40 %

night insulation k = 1.3 W/m^2K shaded sunset and sunrise

Heated Volume 290 m^3 Ventilation Rate winter 1 a.c.h.
summer 2

SOLAR SYSTEM

System energy use(eg. heating) ____

Collector type evacuated tubular collector area(net) 20.3 m^2

orientation south tilt 48°

Storage type long term storage unit 42 m^3 water
heating and hot water storage unit capacity 4 m^3 water

Auxiliary System type heat pump fuel type electricity fuel cost ____

PROJECT SCHEDULE

MILESTONES \ DATE	End of 1975	30.6.76	1.4.77	30.6.79	1980/1981	
Construction completion	16 m² coll.		total 40m² coll.			
Monitoring period		begin monitoring		end monitoring		
Final reports					*	

Report availability — Title (available from): Solar Energy System Design, Nov.30 th. 1978
Proceedings of the Australien-German Workshop
VDI-GET, P.O. Box 1139, 4000 Düsseldorf 1
Fed.Rep. of Germany pp. 225-240

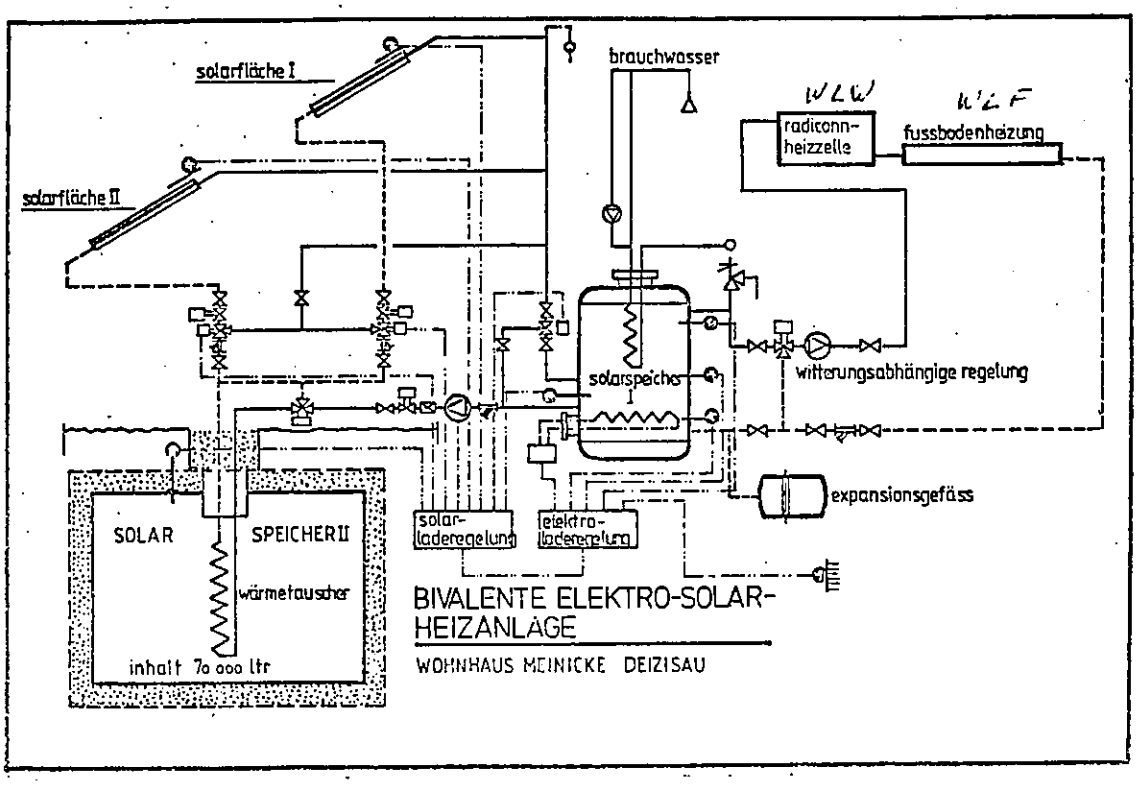
INSTRUMENTATION (existing or anticipated)

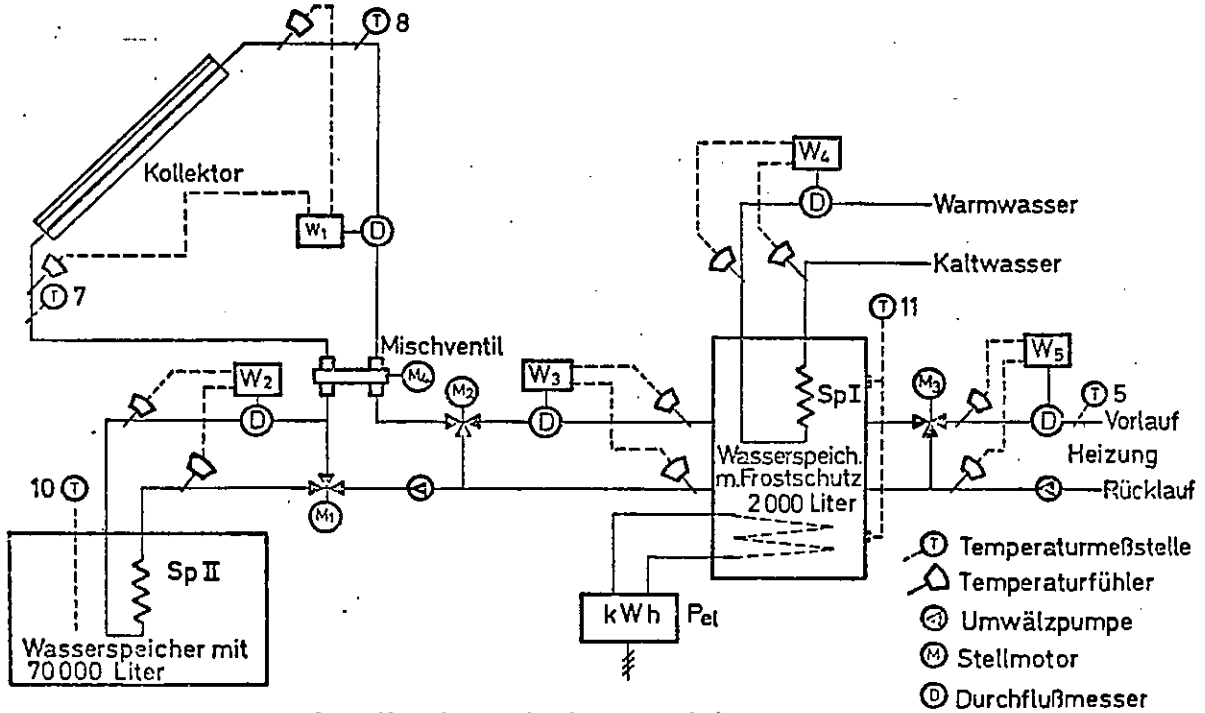
Approximate cost of instrumentation package: 90 000.-
Description of data recording method: manuell listings plus stripcard recording, readings of energy each 24 h.

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days		
	Outdoor Temperature	cont.	± 0.5°C.
	Incident radiation on horizontal surface		
	Incident radiation in plane of collector	cont.	± 5 %
	Relative Humidity		
	Wind Speed		
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	24 h	5 %
	Temperature entering & leaving collectors	cont.	± 1°C.
	Storage		
	Flow rate inputs to storage	24 h	5 %
	Temperature entering & leaving storage	cont.	± 1°C
	Temperature readings in storage(1 or more)	3	
	Auxiliary energy supplied to storage	24 h	± 0.5 %
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	24 h	5 %
	Temperature entering & leaving subsystems	cont.	
	Auxiliary energy supplied to subsystems		
BUILDING SYSTEM	Average DB inside temperature	cont.	0.2°C.
	Infiltration load		
	Auxiliary energy		
	Operating energy	24 h	0.5 %
	Total building energy load		
	Internal energy gains		
	Solar gains		
	Solar as a % of total load		
	Thermal capacity of building		

ILLUSTRATION





Lage der Meßstellen im Solarhaus Deizisau

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Address: SOLAR HOUSE ESSEN

MAIN PARTICIPANTS

	1	2	3
Name	K. Speidel	J.Broschk	
Address	Abt. NTE Dornier System GmbH Postfach 1360 7990 Friedrichshafen	RWE Abt. Anwendungstechnik Postfach 27 4300 Essen 1	
Phone			
Responsibility			

PROJECT DESCRIPTION

CLIMATE

Latitude 51° 25' Longitude 6° 58' Altitude 65,4 DD _____ Base Temp. _____

Sunshine Hours July 152 January 49,3 Annual 1256 (1978)

Source of data Wetteramt ESSEN in middle 1440 hours

Urban X Suburban ____ Rural ____

BUILDING

Floor area 212 m² No. Occupants _____

Design Temperature internal w 22° C s 25 °C

external w -2 s 29 °C

Mass type double glass see report location _____

South Glazing type _____

area(south glass) _____ % of total glass _____

night insulation _____ shaded _____

Heated Volume _____ Ventilation Rate _____ a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) water heating, room heating

Collector type DO-HP area(net) 65 m²

orientation south-south-west tilt 48°

Storage type 2 for waterheating 5 for room heating capacity 600 l each 1200 l each

Auxiliary System type _____ fuel type electric fuel cost _____

PROJECT SCHEDULE

MILESTONES \ DATE	1976	1977	1977 - 1979			
Construction completion	X					
Monitoring period		X	X			
Final reports			X			

Report availability — Title (available from): SOLARHAUS ESSEN enclosed with this paper

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package: 200.000 DM

Description of data recording method: see report

DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days		
	Outdoor Temperature	1 per min	0,5 °C
	Incident radiation on horizontal surface		
	Incident radiation in plane of collector	1 per min	1 %
	Relative Humidity	4 per hour	1 %
	Wind Speed	4 per hour	2 %
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	4 per hour	2 %
	Temperature entering & leaving collectors	1 per hour	0,3 °C
	Storage		
	Flow rate inputs to storage	4 per hour	1 %
	Temperature entering & leaving storage	1 per min	0,3 °C
	Temperature readings in storage(1 or more)	4 per hour	0,3 °C
	Auxiliary energy supplied to storage	continuously	
	Space heat,Space cooling,Hot water Subsystems		
	Flow rates entering subsystems	4 per hour	2 %
	Temperature entering & leaving subsystems	1 per min	0,3 °C
	Auxiliary energy supplied to subsystems	continuously	
BUILDING SYSTEM	Average DB inside temperature	-	-
	Infiltration load	-	-
	Auxiliary energy	continuously	-
	Operating energy	1 per min	
	Total building energy load	1 per day	5 %
	Internal energy gains	-	
	Solar gains	1 per min	3 %
	Solar as a % of total load	1 per day	5 %
	Thermal capacity of building	-	-

IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

Address

Entwicklung eines Meßsystems, Durchführung und Auswertungen von Messungen an der Solaranlage Heggbach

MAIN PARTICIPANTS

	1	2	3
Name	Prof. Ernst Doering		
Address	Fachhochschule für Technik Esslingen D-7300 Esslingen Kanalstrasse 33		
Phone	0711/35112532		
Responsibility			

PROJECT DESCRIPTION

CLIMATE

Latitude 48°09' Longitude 9°54' Altitude 583 m DD _____ Base Temp. _____

Sunshine Hours July _____ January _____ Annual _____

Source of data _____

Urban _____ Suburban _____ Rural x

BUILDING

Floor area 1650 m² No. Occupants _____

Design Temperature internal w 20°C s 22°C °

external w _____ s _____ °

Mass type _____ location Biberach/Wttbg.

South Glazing type k = 1,65 W/m²K

area(south glass) _____ % of total glass _____

night insulation _____ shaded _____

Heated Volume 6 500 m³ Ventilation Rate _____ a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) hot water and heating

Collector type flat - roof - collector area(net) 436 m²

orientation south tilt 10°

Storage type _____ capacity _____

Auxiliary System type district heating fuel type _____ fuel cost _____

PROJECT SCHEDULE

MILESTONES \ DATE	1978	1980	1981-82	1983		
Construction completion	finished					
Monitoring period		preparation measure				
Final reports				finished		

Report availability Title _____

(available from) _____

_____

INSTRUMENTATION (existing or anticipated)

Approximate cost of instrumentation package 70 000.- DM

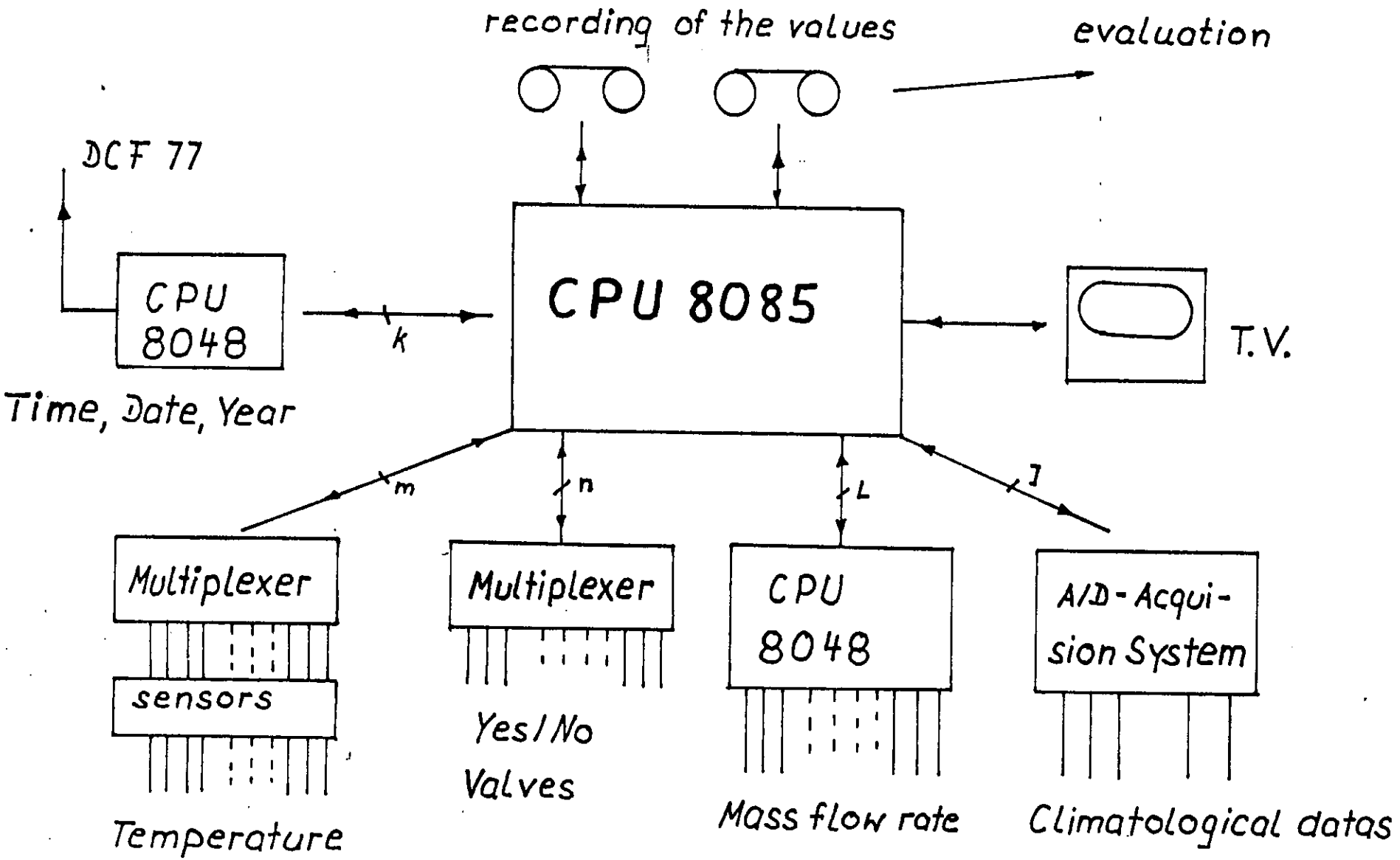
Description of data recording method _____

_____

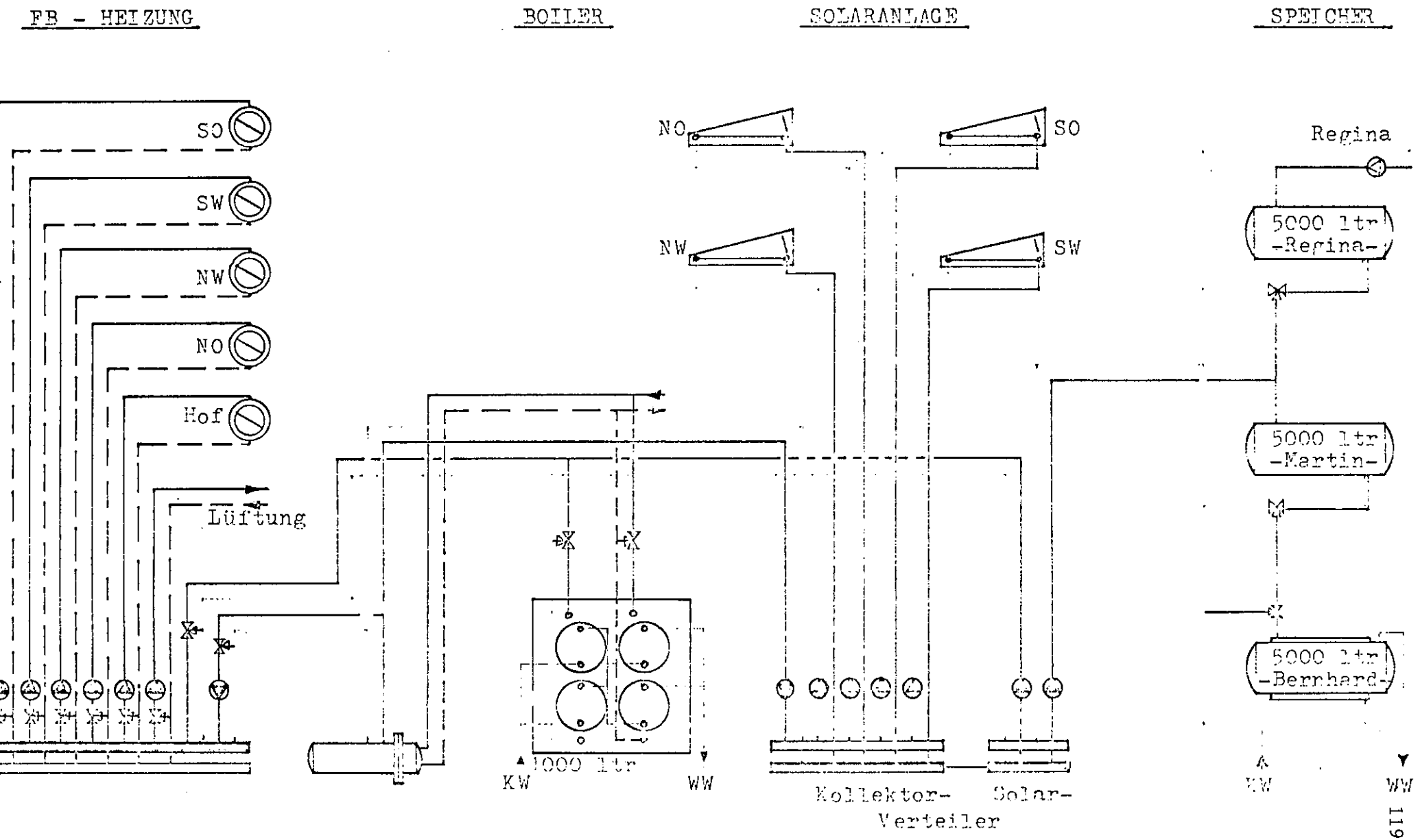
DATA RECORDED

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	5 min	0,2 K
	Outdoor Temperature	5 min	0,1 K
	Incident radiation on horizontal surface	5 min	1 %
	Incident radiation in plane of collector	1 min	1 %
	Relative Humidity	5 min	5 %
	Wind Speed	5 min	1 m/s
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	1 min	0,5 %
	Temperature entering & leaving collectors	1 min	0,1 K
	Storage		
	Flow rate inputs to storage	1 min	2 - 10 %
	Temperature entering & leaving storage	1 min	0,1 K
	Temperature readings in storage(1 or more)	1 min	0,1 K
	Auxiliary energy supplied to storage	1 min	2 %
	Space heat, Space cooling, Hot water Subsystems		
	Flow rates entering subsystems	1 min	2 %
	Temperature entering & leaving subsystems	1 min	0,1 K
	Auxiliary energy supplied to subsystems	1 min	
BUILDING SYSTEM	Average DB inside temperature	5 min	0,1 K
	Infiltration load		
	Auxiliary energy		
	Operating energy		
	Total building energy load		
	Internal energy gains		
	Solar gains		
	Solar as a % of total load		
	Thermal capacity of building		

Scheme of the Solar Data Acquision System



Solaranlage - Heggbacher Einrichtungen



IEA SOLAR R&D

SOLAR ASSISTED LOW ENERGY DWELLINGS
SURVEY

PROJECT TITLE

SOLARHAUS FREIBURG

Address: c/o Klaus Vanoli
Rebstockweg 5
D-7800 FREIBURG - Tiengen

MAIN PARTICIPANTS

	1	2	3
Name Address Phone	Deutsche Forschungs- und Versuchsanstalt für Luft- u. Raumfahrt e.V. Institut für Technische Physik Pfaffenwaldring 38-40 7000 Stuttgart 80 0711 - 7832-485	IST Energietechnik GmbH Ritterweg 1 7842 Kandern-Wollbach 07626 - 7097	-Sol. En. Appl. Lab. Colorado State University Fort Collins Colorado, USA -Philips Forschungslabor Aachen -IEA - Task VI
Responsibility	Dr.-Ing. K.R. Schreitmüller	Dipl.-Phys. K. Vanoli	

PROJECT DESCRIPTION

CLIMATE

Latitude 47°59'20"N Longitude 7°43'E Altitude 218 m DD 3150 Base Temp. 20 °C

Sunshine Hours *) July 266 January 55 Annual 1767

Source of data courtesy Deutscher Wetterdienst/Solarhaus Freiburg-measurement

Urban ____ Suburban ____ Rural x 15 km south-west from Freiburg

*) global radiation sum .....1180 kWh/m²yr

BUILDING

Floor area (heated) 641 m² No. Occupants 25

Design Temperature internal w 20 °C s - °

external w -12 °C s 28 °C °

Mass type limestone 24 cm/concrete location outer walls, floor and ceiling

South Glazing type triple glazed windows (wood frame with rubber sealing)

area(south glass) 20 m² % of total glass 44 %

night insulation ____ shaded south windows shaded by balconies

Heated Volume 1600 m³ Ventilation Rate 1 a.c.h.

SOLAR SYSTEM

System energy use(eg. heating) domestic hot water and/or heating

Collector type evac.tub. CORNING GLASS PHILIPS FORSCH.LAB. area(net) 26.8 m² 27.1 m²

orientation 192.6° tilt 55°

Storage type water DHW-System Heating-System capacity 1.5 and 1 m³ 5.0 and 15 m³

Auxiliary System type DHW electric/oil fired boiler Heating oil fired boiler fuel type crude oil fuel cost 1978 .27 DM/ 1980 .59 DM/

PROJECT SCHEDULE

MILESTONES \ DATE	78	79	80	81	82	
Construction completion	01.09.1978					
Monitoring period		Feb. 1979			July	
Final reports			Status Seminar Report, Hamburg '80		Project summary	

Report availability (available from) subjects: Data acquisition; Progress & prelim. results; Description of solar systems; - of microprocessor control system & software; evaluation technique; modelling & simulation available from DFVLR or IST

INSTRUMENTATION (existing or anticipated)

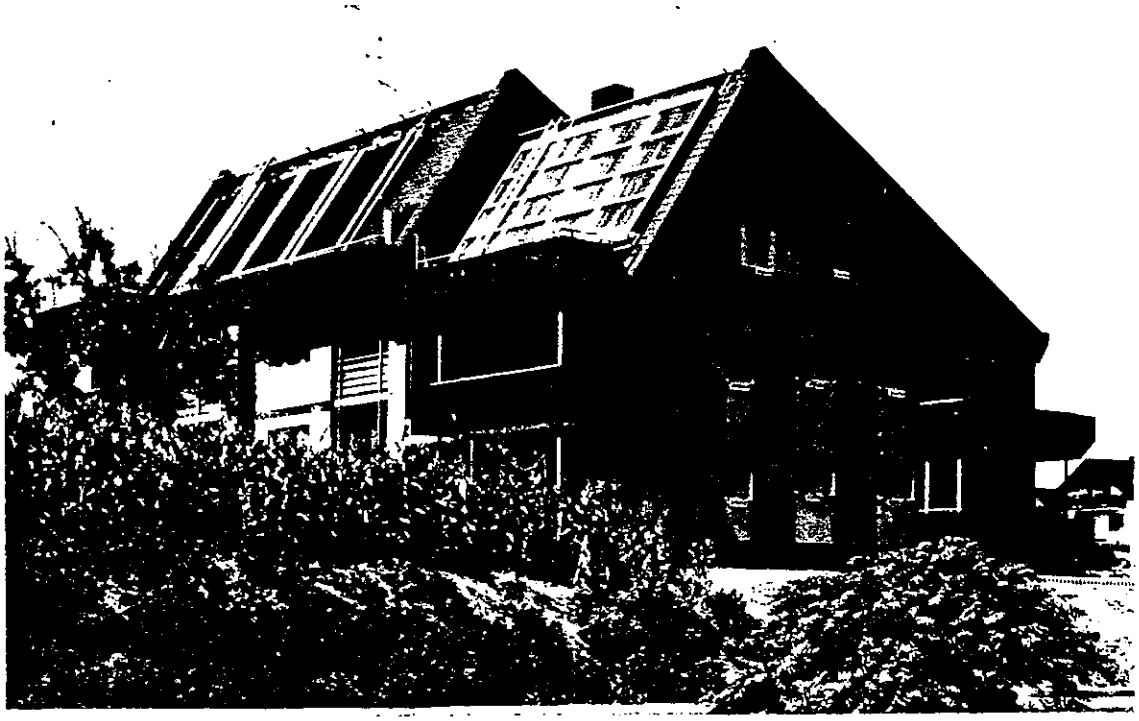
Approximate cost of instrumentation package 280.000,-- DM

Description of data recording method measurement of 180 analogue signals by a scanner-voltmeter subsystem, under control of a user-programmable central computer

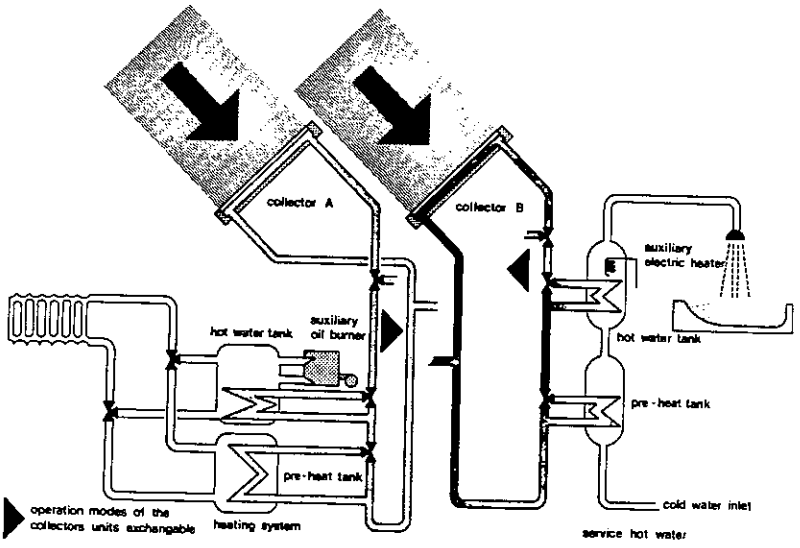
DATA RECORDED (the mean values of all data are recorded on 5 min. time base)

		Frequency of data recording	Accuracy of instrument
METEOROLOICAL	Degree Days	evaluated	± 0.1 °C
	Outdoor Temperature	5 min	± 0.1 °C
	Incident radiation on horizontal surface	5 min	± 2.0 %
	Incident radiation in plane of collector	5 min	± 1.0 %
	Relative Humidity	5 min	± 2.0 %
	Wind Speed	5 min	± 2.0 %
SOLAR SYSTEM	Collectors		
	Flow rate entering collectors	5 min	± 2.0 %
	Temperature entering & leaving collectors	5 min	± 0.02 K
	Storage		
	Flow rate inputs to storage	5 min	± 2.0 %
	Temperature entering & leaving storage	5 min	0.02 K
	Temperature readings in storage(~~XXXXXXX~~) 4	5 min	0.1 K
	Auxiliary energy supplied to storage or	recorded	0.5 % electr. aux.
	Space heat,Space cooling,Hot water Subsystems	evaluated	3.0 % thermal aux.
	Flow rates entering subsystems	5 min	1.0 %
	Temperature entering & leaving subsystems	5 min	0.05 K
	Auxiliary energy supplied to subsystems	evaluated	3.0 %
BUILDING SYSTEM	Average DB inside temperature	5 min	0.1 K
	Infiltration load	evaluated from system parameters and/or recorded data	3.0 - 5.0 %
	Auxiliary energy		2.0 - 3.0 %
	Operating energy		
	Total building energy load		
	Internal energy gains		
	Solar gains		
	Solar as a % of total load		
	Thermal capacity of building		

ILLUSTRATION



Solarhaus Freiburg with the Corning collector (left side) and the Philips collector (right side)



Scheme of the Solar and Conventional System (both collectors may be operated either independently - one furnishing the DHW system, the other one the heating system, and vice versa - or combined; controls done by a microprocessor system with 44 different operation modes)

SECTION II

Building Description

PROJECT	FLOOR AREA m^2	OCCUPANTS	DESIGN TEMPERATURE			
			INTERNAL		EXTERNAL	
			W °C	S °C	W °C	S °C
DENMARK						
Hjortekaer C	135	4 (SIM.)	21	2	-12	--
Hjortekaer F	176	4 (SIM.)	21	2	-12	--
ITALY						
Barra - Const.	130	2	--	--	--	--
Habitat	160	3	20	--	-12	--
JAPAN						
Aratani	320	8	18	28	-12	32
NETHERLANDS						
Bouwcentrum	230	4	20	--	-12	--
SWEDEN						
Bollebygd	140	4	20	--	-15	--
SUN SEC	160	3	20	--	-15	--
SWITZERLAND						
Begnins	210	2 - 3	18	24	-10	30
Les Gen./Coff	137	3 - 4	18	24	-10	30
Payrne Active	211	4 - 5	22	18	-20	30
Renens Passive	220	3 - 4	18	24	-10	30
Stiftung Sonnen.	440	19	22	--	-10	--
UNITED KINGDOM						
Linf. Milt. Keynes	120	4 - 5	18	--	5	--
Linf. Milt. Keynes 2	104	5	18	--	-1	--
Linf. Milt. Keynes 3	104	5	20	--	-1	--
Low En. Hse. Lab (HP)	100	---	20	--	-1	--
Low En. Hse. Lab (Solar)	88	---	20	--	-1	--
Pennyland	100	3 - 4	18	--	5	--
UNITED STATES						
A-Frame Ind.	---	2	--	--	--	--
Albuq. Western II	60/UNIT	---	24	25	-12	38
Cathedral Sq.	---	114	--	--	--	--
Fac. Development	104/UNIT	---	--	--	6	--
Forest City Dillon	12,750	188	19	25	-9	33
Hei Wai Wong	---	19	--	--	--	--
Matt Cannon	229	6 - 8	21	21	14	28
NBS Passive	138	0	18	28	-10	32
Saddle Hill 36	183	4	--	--	--	--
Saddle Hill 77	160	4	--	--	--	--
Sir Galahad Co.	151	1	19	--	-5	--
Solar House I	129	VAR.	22	--	-23	--
Solar House II	129	0	--	--	--	--
Stewart-Teele-Mitchell	179	4	--	--	-18	31
WEST GERMANY						
Aachen Solar House	116	4 (SIM.)	20	--	-12	--
Deizisau Sol. House	180	5	20	20	--	--
Essen Solar House	212	---	22	25	-2	29
FHT Solar House	1,650	---	20	22	--	--
Freiburg Solar House	641	25	20	--	-12	28

Building Description

PROJECT	SOUTHERN GLAZING				
	GLAZING PANES	AREA m^2	NIGHT INSUL.	% OF TOTAL GLAZING	SHADING
DENMARK					
Hjortekaer C	3 - 4	13.3	NO	55%	100%
Hjortekaer F	3	25.4	YES	93%	90%
ITALY					
Barra - Const.	2	15	YES	60%	---
Habitat	2	8.4	---	40%	SUMMER
JAPAN					
Aratani	3	54	YES	77%	S. LOUVER
NETHERLANDS					
Bouwcentrum	2	21.6	---	45%	---
SWEDEN					
Bollebygd	4	18	NO	75%	YES
SUN SEC	3	15	NO	90%	YES
SWITZERLAND					
Begnins	2	28	YES	40%	---
Les Gen./Coff	2	21.3	YES	67%	---
Payrne Active	2	---	---	---	---
Renens Passive	2	24	---	56%	---
Stiftung Sonnen.	2	24	YES	41.5%	0% - 100%
UNITED KINGDOM					
Linf. Milt. Keynes	2	18.4	---	40%	NO
Linf. Milt. Keynes 2	2	18	NO	80%	YES
Linf. Milt. Keynes 3	2	18	NO	80%	YES
Low En. Hse. Lab (HP)	1	5.5	---	54%	---
Low En. Hse. Lab (Solar)	1	3.7	YES	43%	---
Pennyland	1 - 2	9 - 13	YES	30% - 40%	NO
UNITED STATES					
A-Frame Ind.	---	---	---	---	---
Albuq. Western II	---	---	---	---	---
Cathedral Sq.	---	---	---	---	---
Fac. Development	---	---	---	---	---
Forest City Dillon	---	---	NO	---	NO
Hei Wai Wong	---	---	---	---	---
Matt Cannon	---	51	YES	---	10%
NBS Passive	2	32	YES	95%	YES
Saddle Hill 36	---	---	---	---	---
Saddle Hill 77	---	---	---	---	---
Sir Galahad Co.	---	7.5	NO	50%	NO
Solar House I	3	10	NO	35%	YES
Solar House II	2	10	NO	35%	YES
Stewart-Teele-Mitchell	---	---	---	---	---
WEST GERMANY					
Aachen Solar House	2	4.6	YES	40%	E & W
Deizisau Sol. House	2	11.4	YES	31%	---
Essen Solar House	2	---	---	---	---
FHT Solar House	---	---	---	---	---
Freiburg Solar House	3	20	---	44%	YES

Building Description

PROJECT	MASS		VENTILATION RATE (AIR CHANGE/HR.)	HEATED VOLUME m^3
	TYPE	LOCATION		
DENMARK				
Hjortekaer C	CONCRETE	FLOOR	.8	270
Hjortekaer F	CONCRETE	WALL/FL./CEIL.	.6	350
ITALY				
Barra - Const.	CONCRETE	WALL/FL.	1	380
Habitat	MASONRY/CONC.	WALL/FL.	VAR.	320
JAPAN				
Aratani	CONC. BLOCK	WALL	.3	912
NETHERLANDS				
Bouwcentrum	BRICK/CONC.	---	.5	660
SWEDEN				
Bollebygd	---	---	.4	---
SUN SEC	---	---	---	380
SWITZERLAND				
Begnins	CONCRETE	FL./WALL	.3 - .5	743
Les Gen./Coff	CONCRETE	FL./WALL	.3 - .5	319
Payrne Active	---	---	---	613
Renens Passive	CONCRETE	FL./WALL	.3 - .5	700
Stiftung Sonnen.	BRICK	---	.4	1100
UNITED KINGDOM				
Linf. Milt. Keynes	CONC. BLOCK	INNER SKIN	1	300
Linf. Milt. Keynes 2	BRICK/BLOCK	---	1	488
Linf. Milt. Keynes 3	BRICK/BLOCK	---	1	488
Low En. Hse. Lab (HP)	BRICK	---	1	235
Low En. Hse. Lab (Solar)	NO	---	1	207
Pennyland	DENSE CONC.	INNER SKIN	1	250
UNITED STATES				
A-Frame Ind.	---	---	---	---
Albuq. Western II	---	---	---	---
Cathedral Sq.	---	---	---	---
Fac. Development	---	---	---	---
Forest City Dillon	---	---	---	---
Hei Wai Wong	---	---	---	---
Matt Cannon	---	---	---	---
NBS Passive	MASONRY	---	1	370
Saddle Hill 36	---	---	---	---
Saddle Hill 77	---	---	---	---
Sir Galahad Co.	---	---	1.3	379
Solar House I	NO	---	---	---
Solar House II	NO	---	---	---
Stewart-Teele-Mitchell	---	---	---	---
WEST GERMANY				
Aachen Solar House	---	---	1 - 2	290
Deizisau Sol. House	STONE	---	---	400
Essen Solar House	---	---	---	---
FHT Solar House	---	---	---	6500
Freiburg Solar House	CONCRETE	WALL/FL./CEIL.	1	1600

Solar System Description

PROJECT	SYSTEM ENERGY USAGE	COLLECTOR TYPE	COLLECTOR AREA M^2	COLLECTOR ORIENTATION	COLLECTOR TILT DEGREES
DENMARK					
Hjortekaer C	H, DHW	FLAT PLATE	20	S	45°
Hjortekaer F	H, DHW	FLAT PLATE	19	S	45°
ITALY					
Barra - Const.	---	PASSIVE	30	S	90°
Habitat	HEATING	VARIES	41	S	60°
JAPAN					
Aratani	H, DHW	PASSIVE/FLAT PLATE	54/45	S	90°/67°
NETHERLANDS					
Bouwcentrum	HEATING	FLAT PLATE AIR	30	S	55°
SWEDEN					
Bollebygd	---	FLAT PLATE	28	S	70°
SUN SEC	---	FLAT PLATE AIR	32.4	S	70°
SWITZERLAND					
Begnins	HEATING	PASSIVE	28	S15°E	90°
Les Gen./Coff	H, DHW	FLAT PLATE AIR/WATER	14/23	SW/SE	90°/80°
Payrne Active	H, DHW	FLAT PLATE	20	S39°W	43°
Renens Passive	HEATING	PASSIVE	14	S30°W	90°
Stiftung Sonnen.	H, DHW	ENERGY ROOF	113	SE	27°
UNITED KINGDOM					
Linf. Milt. Keynes	HEATING	PASSIVE	---	---	90°
Linf. Milt. Keynes 2	H, DHW	FLAT PLATE	40	S	45°
Linf. Milt. Keynes 3	H, DHW	FLAT PLATE	18.5	S	45°
Low En. Hse. Lab (HP)	PREHEATING	---	63	S	54.5°
Low En. Hse. Lab (Solar)	H, DHW	FLAT PLATE	18	S	42°
Pennyland	HEATING	PASSIVE	---	---	---
UNITED STATES					
A-Frame Ind.	DHW	FLAT PLATE	6	S10°E	21°
Albuq. Western II	HEATING	CONCENTRATOR	541	S	35°
Cathedral Sq.	DHW	FLAT PLATE	170	S42°W	45°
Fac. Development	DHW	FLAT PLATE	49	S	46°
Forest City Dillon	DHW	FLAT PLATE	209	S	40°
Hei Wai Wong	DHW	FLAT PLATE	76	S	24°
Matt Cannon	H, DHW	FLAT PLATE	50	S	34°
NBS Passive	HEATING	PASSIVE	30	S	90°
Saddle Hill 36	H,DHW	FLAT PLATE	37	S	58°
Saddle Hill 77	DHW	FLAT PLATE	7	S	38°
Sir Galahad Co.	H, DHW	---	60	S	45°
Solar House I	H, C, DHW	EVAC. TUBE/FL. PLT.	75/71	S	45°
Solar House II	H, DHW	SOLERON 3000	58	S	45°
Stewart-Teele-Mitchell	H, DHW	FLAT PLATE	41	S	45°
WEST GERMANY					
Aachen Solar House	H, DHW	EVAC. TUBE	20.3	S	48°
Deizisau Sol. House	H, DHW	FLAT PLATE	56	S30°W	28°
Essen Solar House	H, DHW	DO-HP	65	SSW	48°
FHT Solar House	H, DHW	FLAT PLATE	436	S	10°
Freiburg Solar House	H, DHW	EVAC. TUBE	54	S13°W	55°

Solar System Description

PROJECT	STORAGE		AUXILIARY SYSTEM	
	TYPE	CAPACITY m^3	TYPE	FUEL
DENMARK				
Hjortekaer C	TANK	1.8	HT. PUMP/RESIST.	ELEC.
Hjortekaer F	TANK	1.5	BOILER	GAS
ITALY				
Barra - Const.	MASS	---	WOOD BURNER	WOOD
Habitat	TANK/BASIN	2/50	HEAT PUMP	ELEC.
JAPAN				
Aratani	WALL/TANK	---	BOILER	WASTE HEAT
NETHERLANDS				
Bouwcentrum	CONC. SLAB	---	FURNACE	GAS
SWEDEN				
Bollebygd	STEEL WATER TANK	3	FURNACE	WOOD/ELEC.
SUN SEC	STEEL WATER TANK	3	HT. PUMP/RESIST.	ELEC.
SWITZERLAND				
Begnins	FLOOR/CHIMNEY	10	RESISTANCE	ELEC.
Les Gen./Coff	TANK	3.7	WOOD BURNER	WOOD
Payrne Active	WATER AND BETON	16	BOILER	WOOD
Renens Passive	CONCRETE	---	FURNACE	GAS
Stiftung Sonnen.	WATER	1.2	FURN./HT. PUMP	OIL/ELEC.
UNITED KINGDOM				
Linf. Milt. Keynes	---	---	BOILER	GAS
Linf. Milt. Keynes 2	WATER	2	BOILER	---
Linf. Milt. Keynes 3	WATER	6.8	BOILER	GAS
Low En. Hse. Lab (HP)	NO	---	HEAT PUMP	ELEC.
Low En. Hse. Lab (Solar)	WATER	42.6	HEAT PUMP	ELEC.
Pennyland	---	---	FURNACE	GAS
UNITED STATES				
A-Frame Ind.	WATER TANK	.5	RESISTANCE	ELEC.
Albuq. Western II	CONC. TANK	228	BOILER	GAS
Cathedral Sq.	WATER	11	BOILER	GAS
Fac. Development	GLASS LINED TANK	4	RESISTANCE	ELEC.
Forest City Dillon	LIQUID	13	FURNACE	#2 OIL
Hei Wai Wong	WATER	5	HEATER	GAS/ELEC.
Matt Cannon	LIQUID	4	NONE	---
NBS Passive	SLAB/WALL	---	RESISTANCE	ELEC.
Saddle Hill 36	WATER	3	FURNACE	#2 OIL
Saddle Hill 77	WATER TANK	.5	HEATER	GAS
Sir Galahad Co.	STEEL WATER TANK	6	HT. PUMP/RESIST.	ELEC.
Solar House I	GALV. ST. WATER TANK	34	BOILER	GAS
Solar House II	PEBBLE BED	10.3	HEAT PUMP	ELEC.
Stewart-Teele-Mitchell	WATER	4	BOILER	GAS
WEST GERMANY				
Aachen Solar House	TANK	46	HEAT PUMP	ELEC.
Deizisau Sol. House	TANK	72	BOILER	ELEC.
Essen Solar House	---	---	---	ELEC.
FHT Solar House	---	---	DISTRICT HEAT	---
Freiburg Solar House	WATER	225	BOILER	OIL

Instrumentation Description

PROJECT	MONITOR PERIOD BEGINS	MONITOR PERIOD ENDS	INSTRUMENTATION	
			COST	DESCRIPTION
DENMARK				
Hjortekaer C	9-78	4-82	$27-36,000	CASSETTES, TRANS. TO HARD DISC
Hjortekaer F	4-79	4-82	$27-36,000	CASSETTES, TRANS. TO HARD DISC
ITALY				
Barra - Const.	1980	1982	$6,000	DATA LOGGER, CHART RECORDER
Habitat	1977	---	$40,000	HP 3052A, DATA ACQUISITION
JAPAN				
Aratani	1-80	---	---	EPLY RADIOM. + INT. + RECORD
NETHERLANDS				
Bouwcentrum	3-80	10-81	DFL 50,000	DATA LOGGER, CARTRIDGE STOR.
SWEDEN				
Bollebygd	1-79	4-81	60,000 DERS.	MANUAL ENERGY; CHART TEMP.
SUN SEC	4-80	10-81	---	MAG. TAPE CASSETTES
SWITZERLAND				
Begnins	11-78	6-80	$20,000	64 CH COUNTER + INT. + MAG. RECORD
Les Gen./Coff	9-79	6-81	$20,000	64 CH COUNTER + INT. + MAG. RECORD
Payrne Active	1980	1981	---	CASSETTE - TAPE
Renens Passive	9-80	1-82	SFR. 60,000	HP DATA ACQ. + CASSETTE RECORD
Stiftung Sonnen.	10-78	12-82	FR. 40,000	COUNTERS + RECORDERS
UNITED KINGDOM				
Linf. Milt. Keynes	1-81	12-82	6,000/UNIT	DATA LOGGER + MAG. CASSETTE
Linf. Milt. Keynes 2	---	---	45,000	DATA LOGGER + MAG. CASSETTE
Linf. Milt. Keynes 3	---	---	25,000	DIGITAL MAG. CASSETTE
Low En. Hse. Lab (HP)	---	---	25,000	PDP II DATA LOGGER
Low En. Hse. Lab (Solar)	---	---	25,000	PDP II DATA LOGGER
Pennyland	2-81	6-82	350/UNIT	INT. DISPLAY
UNITED STATES				
A-Frame Ind.	2-78	6-80	$3,510	DATA ON TAPE, DAILY CPU
Albuq. Western II	1-78	8-80	---	DATA ON TAPE, DAILY CPU
Cathedral Sq.	6-79	8-80	---	DATA ON TAPE, DAILY CPU
Fac. Development	1-78	8-80	---	DATA ON TAPE, DAILY CPU
Forest City Dillon	1-79	12-80	$30,000	---
Hei Wai Wong	10-77	8-80	---	DATA ON TAPE, DAILY CPU
Matt Cannon	5-78	---	---	DATA ON TAPE, DAILY CPU
NBS Passive	3-79	---	---	DATA ON TAPE, DAILY CPU
Saddle Hill 36	11-80	10-82	$50,000	PH 2100, MAG. TAPE
Saddle Hill 77	1-79	---	---	DATA ON TAPE, DAILY CPU
Sir Galahad Co.	2-78	---	$18,000	DATA ON TAPE, DAILY CPU
Solar House I	1-75	---	---	DORIC 220 DATA LOG. + TAPE RECORD
Solar House II	10-78	6-79	---	DIGITAL, PRINTER, TAPE DECK
Stewart-Teele-Mitchell	4-78	8-80	$800	DATA ON TAPE, DAILY CPU
WEST GERMANY				
Aachen Solar House	1976	6-78	---	P855 COMPUTER
Deizisau Sol. House	7-76	7-79	90,000	STRIPCARD RECORDER
Essen Solar House	1977	1979	200,000 DM	---
FHT Solar House	1980	1982	70,000	---
Freiburg Solar House	2-79	7-82	280,000 DM	SCANNER UNDER CENTRAL COMP.

Meteorological Instrumentation

PROJECT	DEGREE DAYS	OUTDOOR TEMP.	HORIZ. INCID. RADIATION	INCID. COLLECTOR RADIATION	REL. HUM.	WIND SPEED
DENMARK						
Hjortekaer C	10 SEC.	10 SEC.	10 SEC.	10 SEC.	10 SEC.	10 SEC.
Hjortekaer F	10 SEC.	10 SEC.	10 SEC.	10 SEC.	10 SEC.	10 SEC.
ITALY						
Barra - Const.	---	1 HR.	---	1 HR.	---	---
Habitat	1 MIN.	1 MIN.	1 MIN.	1 MIN.	1 MIN.	CONT.
JAPAN						
Aratani	CONT.	CONT.	---	CONT.	---	---
NETHERLANDS						
Bouwcentrum	---	7 SEC.	---	7 SEC.	---	---
SWEDEN						
Bollebygd	---	CONT.	---	---	CONT.	---
SUN SEC	---	1 HR.	10 MIN.	10 MIN.	---	10 MIN.
SWITZERLAND						
Begnins	30 MIN.	30 MIN.	30 MIN.	30 MIN.	30 MIN.	30 MIN.
Les Gen./Coff	30 MIN.	30 MIN.	30 MIN.	30 MIN.	30 MIN.	30 MIN.
Payrne Active	15 MIN.	15 MIN.	15 MIN.	15 MIN.	15 MIN.	15 MIN.
Renens Passive	---	30 MIN.	---	30 MIN.	---	30 MIN.
Stiftung Sonnen.	---	CONT.	---	---	---	---
UNITED KINGDOM						
Linf. Milt. Keynes	1 HR.	1 HR.	1 HR.	1 HR.	1 HR.	1 HR.
Linf. Milt. Keynes 2	1 DAY	1 HR.	2 MIN.	2 MIN.	1 HR.	1 HR.
Linf. Milt. Keynes 3	1 HR.	1 HR.	1 HR.	1 HR.	---	---
Low En. Hse. Lab (HP)	---	---	---	---	---	---
Low En. Hse. Lab (Solar)	---	---	---	---	---	---
Pennyland	---	1 HR.	1 HR.	1 HR.	1 HR.	1 HR.
UNITED STATES						
A-Frame Ind.	---	320 SEC.	---	320 SEC.	---	---
Albuq. Western II	---	320 SEC.	---	320 SEC.	---	---
Cathedral Sq.	---	320 SEC.	---	320 SEC.	---	---
Fac. Development	---	320 SEC.	---	320 SEC.	---	---
Forest City Dillon	---	320 SEC.	---	320 SEC.	320 SEC.	320 SEC.
Hei Wai Wong	---	320 SEC.	---	320 SEC.	---	320 SEC.
Matt Cannon	---	320 SEC.	---	320 SEC.	---	---
NBS Passive	---	5 MIN.	---	---	---	---
Saddle Hill 36	---	320 SEC.	---	320 SEC.	---	320 SEC.
Saddle Hill 77	---	320 SEC.	---	320 SEC.	---	320 SEC.
Sir Galahad Co.	---	320 SEC.	---	320 SEC.	---	---
Solar House I	---	10 MIN.	10 MIN.	10 MIN.	10 MIN.	10 MIN.
Solar House II	---	300 SEC.	---	300 SEC.	300 SEC.	300 SEC.
Stewart-Teele-Mitchell	---	320 SEC.	---	300 SEC.	---	---
WEST GERMANY						
Aachen Solar House	---	10 MIN.	1 MIN.	1 MIN.	10 MIN.	1 MIN.
Deizisau Sol. House	---	CONT.	---	CONT.	---	---
Essen Solar House	---	1 MIN.	---	1 MIN.	15 MIN.	15 MIN.
FHT Solar House	5 MIN.	5 MIN.	5 MIN.	1 MIN.	5 MIN.	5 MIN.
Freiburg Solar House	---	5 MIN.	5 MIN.	5 MIN.	5 MIN.	5 MIN.

Solar System Instrumentation

PROJECT	COLLECTORS		STORAGE			
	FLOW RATE IN	TEMP. IN AND OUT	FLOW RATE IN	TEMP. IN AND OUT	TEMP. INSIDE	AUX. ENERGY INPUT
DENMARK						
Hjortekaer C	10 SEC.	10 SEC.	10 SEC.	10 SEC.	10 SEC.	---
Hjortekaer F	10 SEC.	10 SEC.	10 SEC.	10 SEC.	10 SEC.	10 SEC.
ITALY						
Barra - Const.	1 HR.	1 HR.	1 HR.	1 HR.	1 HR.	---
Habitat	1 MIN.	1 MIN.	1 MIN.	1 MIN.	1 MIN.	1 MIN.
JAPAN						
Aratani	---	---	---	---	CONT.	---
NETHERLANDS						
Bouwcentrum	7 SEC.	7 SEC.	---	---	20 MIN.	---
SWEDEN						
Bollebygd	---	---	1 WEEK	1 WEEK	---	---
SUN SEC	1 HR.	1 HR.	1 HR.	1 HR.	1 HR.	---
SWITZERLAND						
Begnins	---	---	---	---	---	---
Les Gen./Coff	30 MIN.	30 MIN.	30 MIN.	30 MIN.	30 MIN.	30 MIN.
Payrne Active	15 MIN.	15 MIN.	15 MIN.	15 MIN.	15 MIN.	15 MIN.
Renens Passive	30 MIN.	30 MIN.	---	---	---	---
Stiftung Sonnen.	---	CONT.	---	CONT.	CONT.	CONT.
UNITED KINGDOM						
Linf. Milt. Keynes	---	---	---	---	---	---
Linf. Milt. Keynes 2	CONT.	CONT.	VAR.	VAR.	VAR.	VAR.
Linf. Milt. Keynes 3	1 HR.	1 HR.	---	---	1 HR.	1 HR.
Low En. Hse. Lab (HP)	---	---	---	---	---	---
Low En. Hse. Lab (Solar)	---	---	---	---	---	---
Pennyland	---	---	---	---	---	---
UNITED STATES						
A-Frame Ind.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
Albuq. Western II	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
Cathedral Sq.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
Fac. Development	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
Forest City Dillon	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.
Hei Wai Wong	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
Matt Cannon	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
NBS Passive	VAR.	5 MIN.	---	---	5 MIN.	---
Saddle Hill 36	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC	---
Saddle Hill 77	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
Sir Galahad Co.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.
Solar House I	10 MIN.	10 MIN.	10 MIN.	10 MIN.	10 MIN.	10 MIN.
Solar House II	300 SEC.	300 SEC.	300 SEC.	300 SEC.	300 SEC.	---
Stewart-Teele-Mitchell	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
WEST GERMANY						
Aachen Solar House	1 MIN.	1 MIN.	1 MIN.	1 MIN.	10 MIN.	10 MIN.
Deizisau Sol. House	1 DAY	CONT.	1 DAY	CONT.	---	1 DAY
Essen Solar House	15 MIN.	1 HR.	15 MIN.	1 MIN.	15 MIN.	CONT.
FHT Solar House	1 MIN.	1 MIN.	1 MIN.	1 MIN.	1 MIN.	---
Freiburg Solar House	5 MIN.	5 MIN.	5 MIN.	5 MIN.	5 MIN.	

Solar System Instrumentation

PROJECT	HEATING, COOLING, HOT WATER SYSTEMS		
	SUBSYSTEM INPUT FLOW	TEMP. IN AND OUT	AUX. ENERGY SUPPLIED
DENMARK			
Hjortekaer C	10 SEC.	10 SEC.	10 SEC.
Hjortekaer F	10 SEC.	10 SEC.	10 SEC.
ITALY			
Barra - Const.	1 HR.	1 HR.	---
Habitat	1 MIN.	1 MIN.	1 MIN.
JAPAN			
Aratani	---	---	1 DAY
NETHERLANDS			
Bouwcentrum	7 SEC.	7 SEC.	7 SEC.
SWEDEN			
Bollebygd	1 WEEK	1 WEEK	1 WEEK
SUN SEC	1 HR.	1 HR.	1 HR.
SWITZERLAND			
Begnins	---	---	---
Les Gen./Coff	30 MIN.	30 MIN.	---
Payrne Active	15 MIN.	15 MIN.	15 MIN.
Renens Passive	---	---	---
Stiftung Sonnen.	CONT.	CONT.	CONT.
UNITED KINGDOM			
Linf. Milt. Keynes	---	---	---
Linf. Milt. Keynes 2	CONT.	CONT.	CONT.
Linf. Milt. Keynes 3	1 HR.	1 HR.	1 HR.
Low En. Hse. Lab (HP)	---	---	---
Low En. Hse. Lab (Solar)	---	---	---
Pennyland	---	---	---
UNITED STATES			
A-Frame Ind.	---	---	---
Albuq. Western II	320 SEC.	320 SEC.	320 SEC.
Cathedral Sq.	320 SEC.	320 SEC.	---
Fac. Development	320 SEC.	320 SEC.	320 SEC.
Forest City Dillon	320 SEC.	320 SEC.	320 SEC.
Hei Wai Wong	320 SEC.	320 SEC.	320 SEC.
Matt Cannon	320 SEC.	320 SEC.	320 SEC.
NBS Passive	CONT.	5 MIN.	5 MIN.
Saddle Hill 36	320 SEC.	320 SEC.	320 SEC.
Saddle Hill 77	320 SEC.	320 SEC.	320 SEC.
Sir Galahad Co.	320 SEC.	320 SEC.	320 SEC.
Solar House I	10 MIN.	10 MIN.	10 MIN.
Solar House II	300 SEC.	300 SEC.	300 SEC.
Stewart-Teele-Mitchell	320 SEC.	320 SEC.	320 SEC.
WEST GERMANY			
Aachen Solar House	10 MIN.	10 MIN.	10 MIN.
Deizisau Sol. House	1 DAY	CONT.	---
Essen Solar House	15 MIN.	1 MIN.	CONT.
FHT Solar House	1 MIN.	1 MIN.	1 MIN.
Freiburg Solar House	5 MIN.	5 MIN.	---

Solar System Instrumentation

PROJECT	COLLECTORS		STORAGE			
	FLOW RATE IN	TEMP. IN AND OUT	FLOW RATE IN	TEMP. IN AND OUT	TEMP. INSIDE	AUX. ENERGY INPUT
DENMARK						
Hjortekaer C	10 SEC.	10 SEC.	10 SEC.	10 SEC.	10 SEC.	---
Hjortekaer F	10 SEC.	10 SEC.	10 SEC.	10 SEC.	10 SEC.	10 SEC.
ITALY						
Barra - Const.	1 HR.	1 HR.	1 HR.	1 HR.	1 HR.	---
Habitat	1 MIN.	1 MIN.	1 MIN.	1 MIN.	1 MIN.	1 MIN.
JAPAN						
Aratani	---	---	---	---	CONT.	---
NETHERLANDS						
Bouwcentrum	7 SEC.	7 SEC.	---	---	20 MIN.	---
SWEDEN						
Bollebygd	---	---	1 WEEK	1 WEEK	---	---
SUN SEC	1 HR.	1 HR.	1 HR.	1 HR.	1 HR.	---
SWITZERLAND						
Begnins	---	---	---	---	---	---
Les Gen./Coff	30 MIN.	30 MIN.	30 MIN.	30 MIN.	30 MIN.	30 MIN.
Payrne Active	15 MIN.	15 MIN.	15 MIN.	15 MIN.	15 MIN.	15 MIN.
Renens Passive	30 MIN.	30 MIN.	---	---	---	---
Stiftung Sonnen.	---	CONT.	---	CONT.	CONT.	CONT.
UNITED KINGDOM						
Linf. Milt. Keynes	---	---	---	---	---	---
Linf. Milt. Keynes 2	CONT.	CONT.	VAR.	VAR.	VAR.	VAR.
Linf. Milt. Keynes 3	1 HR.	1 HR.	---	---	1 HR.	1 HR.
Low En. Hse. Lab (HP)	---	---	---	---	---	---
Low En. Hse. Lab (Solar)	---	---	---	---	---	---
Pennyland	---	---	---	---	---	---
UNITED STATES						
A-Frame Ind.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
Albuq. Western II	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
Cathedral Sq.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
Fac. Development	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
Forest City Dillon	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.
Hei Wai Wong	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
Matt Cannon	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
NBS Passive	VAR.	5 MIN.	---	---	5 MIN.	---
Saddle Hill 36	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC	---
Saddle Hill 77	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
Sir Galahad Co.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.
Solar House I	10 MIN.	10 MIN.	10 MIN.	10 MIN.	10 MIN.	10 MIN.
Solar House II	300 SEC.	300 SEC.	300 SEC.	300 SEC.	300 SEC.	---
Stewart-Teele-Mitchell	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.	---
WEST GERMANY						
Aachen Solar House	1 MIN.	1 MIN.	1 MIN.	1 MIN.	10 MIN.	10 MIN.
Deizisau Sol. House	1 DAY	CONT.	1 DAY	CONT.	---	1 DAY
Essen Solar House	15 MIN.	1 HR.	15 MIN.	1 MIN.	15 MIN.	CONT.
FHT Solar House	1 MIN.	1 MIN.	1 MIN.	1 MIN.	1 MIN.	---
Freiburg Solar House	5 MIN.	5 MIN.	5 MIN.	5 MIN.	5 MIN.	

Solar System Instrumentation

PROJECT	HEATING, COOLING, HOT WATER SYSTEMS		
	SUBSYSTEM INPUT FLOW	TEMP. IN AND OUT	AUX. ENERGY SUPPLIED
DENMARK			
Hjortekaer C	10 SEC.	10 SEC.	10 SEC.
Hjortekaer F	10 SEC.	10 SEC.	10 SEC.
ITALY			
Barra - Const.	1 HR.	1 HR.	---
Habitat	1 MIN.	1 MIN.	1 MIN.
JAPAN			
Aratani	---	---	1 DAY
NETHERLANDS			
Bouwcentrum	7 SEC.	7 SEC.	7 SEC.
SWEDEN			
Bollebygd	1 WEEK	1 WEEK	1 WEEK
SUN SEC	1 HR.	1 HR.	1 HR.
SWITZERLAND			
Begnins	---	---	---
Les Gen./Coff	30 MIN.	30 MIN.	---
Payrne Active	15 MIN.	15 MIN.	15 MIN.
Renens Passive	---	---	---
Stiftung Sonnen.	CONT.	CONT.	CONT.
UNITED KINGDOM			
Linf. Milt. Keynes	---	---	---
Linf. Milt. Keynes 2	CONT.	CONT.	CONT.
Linf. Milt. Keynes 3	1 HR.	1 HR.	1 HR.
Low En. Hse. Lab (HP)	---	---	---
Low En. Hse. Lab (Solar)	---	---	---
Pennyland	---	---	---
UNITED STATES			
A-Frame Ind.	---	---	---
Albuq. Western II	320 SEC.	320 SEC.	320 SEC.
Cathedral Sq.	320 SEC.	320 SEC.	---
Fac. Development	320 SEC.	320 SEC.	320 SEC.
Forest City Dillon	320 SEC.	320 SEC.	320 SEC.
Hei Wai Wong	320 SEC.	320 SEC.	320 SEC.
Matt Cannon	320 SEC.	320 SEC.	320 SEC.
NBS Passive	CONT.	5 MIN.	5 MIN.
Saddle Hill 36	320 SEC.	320 SEC.	320 SEC.
Saddle Hill 77	320 SEC.	320 SEC.	320 SEC.
Sir Galahad Co.	320 SEC.	320 SEC.	320 SEC.
Solar House I	10 MIN.	10 MIN.	10 MIN.
Solar House II	300 SEC.	300 SEC.	300 SEC.
Stewart-Teele-Mitchell	320 SEC.	320 SEC.	320 SEC.
WEST GERMANY			
Aachen Solar House	10 MIN.	10 MIN.	10 MIN.
Deizisau Sol. House	1 DAY	CONT.	---
Essen Solar House	15 MIN.	1 MIN.	CONT.
FHT Solar House	1 MIN.	1 MIN.	1 MIN.
Freiburg Solar House	5 MIN.	5 MIN.	---

Building Instrumentation

PROJECT	INSIDE DB TEMPERATURE	INFIL. LOAD	AUXILIARY ENERGY	OPER. ENERGY	TOTAL BUILDING ENERGY USED
DENMARK					
Hjortekaer C	10 MIN.	10 MIN.	10 MIN.	10 MIN.	10 MIN.
Hjortekaer F	10 MIN.	10 MIN.	10 MIN.	10 MIN.	10 MIN.
ITALY					
Barra - Const.	1 HR.	---	1 DAY	---	1 MONTH
Habitat	1 MIN.	---	1 MIN.	1 MIN.	1 MIN.
JAPAN					
Aratani	CONT.	1 MONTH	1 DAY	---	1 MONTH
NETHERLANDS					
Bouwcentrum	7 SEC.	---	---	---	7 SEC.
SWEDEN					
Bollebygd	CONT.	---	1 WEEK	1 WEEK	---
SUN SEC	1 HR.	---	---	1 HR.	1 HR.
SWITZERLAND					
Begnins	30 MIN.	30 MIN.	30 MIN.	30 MIN.	30 MIN.
Les Gen./Coff	30 MIN.	30 MIN.	30 MIN.	30 MIN.	30 MIN.
Payrne Active	15 MIN.	---	15 MIN.	15 MIN.	15 MIN.
Renens Passive	30 MIN.	---	---	---	---
Stiftung Sonnen.	CONT.	VAR.	CONT.	CONT.	CONT.
UNITED KINGDOM					
Linf. Milt. Keynes	1 HR.	1 HR.	1 HR.	1 HR.	1 HR.
Linf. Milt. Keynes 2	1 HR.	---	1 DAY	CONT.	1 DAY
Linf. Milt. Keynes 3	---	---	1 HR.	1 HR.	1 DAY
Low En. Hse. Lab (HP)	---	---	---	---	---
Low En. Hse. Lab (Solar)	---	---	---	---	---
Pennyland	1 WEEK	---	1 WEEK	---	1 WEEK
UNITED STATES					
A-Frame Ind.	---	---	---	---	---
Albuq. Western II	---	---	---	---	---
Cathedral Sq.	---	---	---	320 SEC.	---
Fac. Development	---	---	---	---	---
Forest City Dillon	---	---	---	---	---
Hei Wai Wong	---	---	---	---	---
Matt Cannon	---	---	---	---	---
NBS Passive	5 MIN.	---	CONT.	CONT.	---
Saddle Hill 36	320 SEC.	---	320 SEC.	320 SEC.	---
Saddle Hill 77	320 SEC.	320 SEC.	320 SEC.	320 SEC.	320 SEC.
Sir Galahad Co.	320 SEC.	---	320 SEC.	320 SEC.	---
Solar House I	10 MIN.	---	10 MIN.	10 MIN.	---
Solar House II	300 SEC.	---	300 SEC.	300 SEC.	---
Stewart-Teele-Mitchell	---	---	---	320 SEC.	---
WEST GERMANY					
Aachen Solar House	10 MIN.	---	10 MIN.	10 MIN.	10 MIN.
Deizisau Sol. House	CONT.	---	---	1 DAY	---
Essen Solar House	---	---	CONT.	1 MIN.	1 DAY
FHT Solar House	5 MIN.	---	---	---	---
Freiburg Solar House	5 MIN.	---	---	---	---

Building Instrumentation

PROJECT	INTERNAL GAINS	SOLAR GAINS	SOLAR % OF TOTAL LOAD	THERMAL CAP. OF BUILDING
DENMARK				
Hjortekaer C	10 MIN.	10 MIN.	---	---
Hjortekaer F	10 MIN.	10 MIN.	---	---
ITALY				
Barra - Const.	1 MONTH	1 MONTH	1 MONTH	---
Habitat	1 DAY	---	---	---
JAPAN				
Aratani	---	---	---	---
NETHERLANDS				
Bouwcentrum	---	---	7 SEC.	---
SWEDEN				
Bollebygd	---	---	---	---
SUN SEC	1 HR.	1 HR.	---	---
SWITZERLAND				
Begnins	30 MIN.	30 MIN.	30 MIN.	30 MIN.
Les Gen./Coff	30 MIN.	30 MIN.	30 MIN.	---
Payrne Active	---	15 MIN.	15 MIN.	---
Renens Passive	---	---	---	---
Stiftung Sonnen.	---	---	---	---
UNITED KINGDOM				
Linf. Milt. Keynes	1 HR.	1 HR.	1 HR.	---
Linf. Milt. Keynes 2	---	---	---	---
Linf. Milt. Keynes 3	1 HR.	1 HR.	1 DAY	1 DAY
Low En. Hse. Lab (HP)	---	---	---	---
Low En. Hse. Lab (Solar)	---	---	---	---
Pennyland	---	1 HR.	1 WEEK	---
UNITED STATES				
A-Frame Ind.	---	---	---	---
Albuq. Western II	---	---	---	---
Cathedral Sq.	---	---	---	---
Fac. Development	---	---	---	---
Forest City Dillon	---	---	---	---
Hei Wai Wong	---	---	---	---
Matt Cannon	---	---	---	---
NBS Passive	5 MIN.	5 MIN.	1 MONTH	1 MONTH
Saddle Hill 36	---	---	---	---
Saddle Hill 77	320 SEC.	320 SEC.	320 SEC.	320 SEC.
Sir Galahad Co.	---	---	---	---
Solar House I	---	---	---	---
Solar House II	---	---	---	---
Stewart-Teele-Mitchell	---	---	---	---
WEST GERMANY				
Aachen Solar House	10 MIN.	---	---	---
Deizisau Sol. House	---	---	---	---
Essen Solar House	---	1 MIN.	1 DAY	---
FHT Solar House	---	---	---	---
Freiburg Solar House	---	---	---	---