A Sustainable Solar House with OM Solar System in Hamamatsu, Japan

International Energy Agency

IEA – SCH Task 28 / ECBCS Annex 38:

Sustainable Solar Housing

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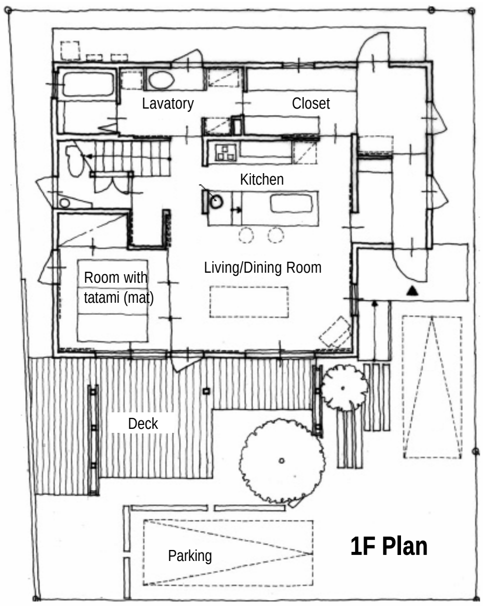
The project

This house was built at Hamamatsu of Shizuoka Pref. in the fall of 2002. It is a prefabricated house (named Volks Haus -ProjectA) equipped with the OM Solar system. Volks Haus are a concept and an aim that is completely different from those of prefabricated houses offered by Japan's home manufacturers. The fundamental idea of Volks Haus is to use a wide space as effectively as possible before dividing it into rooms, hall, etc. This is different from building houses from a finished floor plan. The plywood used for structure is left in its original state to form the inner walls. The ceilings and the floor of the second floor are also left in the original state of laminated wood and plywood. This method can be called an exposed wood method, from its resemblance to the exposed concrete method.

The body of Volks Haus is built of prefabricated posts and beams that are joined by metal joints. Insulated panels are fitted in between posts. These panel serve as braces. Because it uses metal joints instead of traditional joints, the house can be put together without conventional skill. The project has been applied to more than 3,000 homes and the OM Solar system has been used in more than 20,000 homes.

Southern view of the house

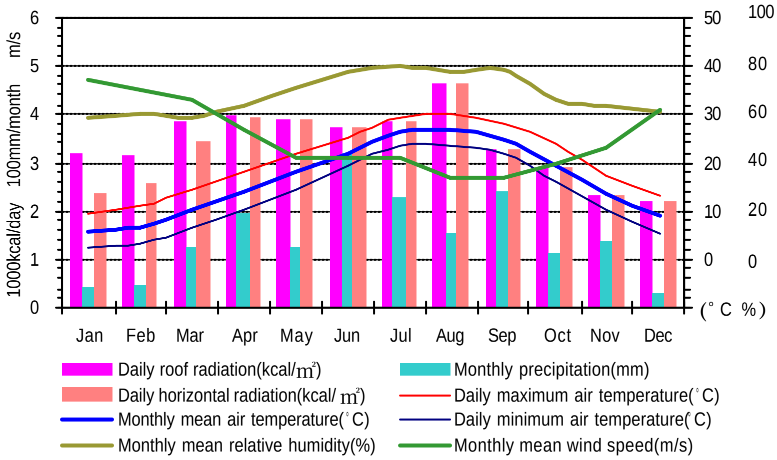


Design concept of the house

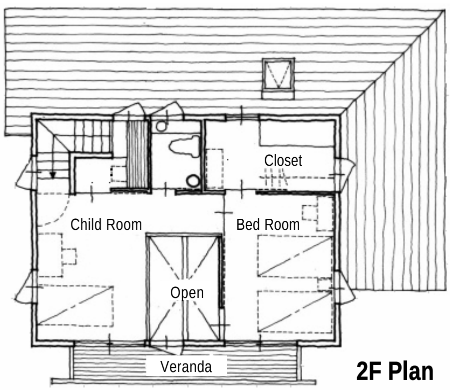
The house was ordered by a three-person family. The husband was a salary man in age of 35 and his child was a three-month-old boy. Since married, the couple was living in an apartment. After their son was born, they hoped to build a theirs own home with their savings.

The house was aimed to be designed based on the following points.

- Employ the OM Solar system to create a comfortable living space by using the solar heat.
- Externals of the building are well-matched with the wooden deck and planting.
- Built of wood and internal walls are finished with plaster.
- The kitchen is the center of the home and Island-shaped.
- The living room is integrated with the deck.



Annual meteorological data for Hamamatsu



Climatic conditions of the location (Hamamatsu)

Hamamatsu is located in the central middle part of Japan (N34°42', L137°43 '), where heating is required for five months from November to April. Because the daily sum of horizontal solar radiation exceeds 2000kcal/m^{2}day in these months, the effect of the OM Solar heating can be expected in the heating-required months.

Solar system Specification
Glass-covered heat-collector: $16m^2$
Metals heat collector: $11m^2$
Under-floor storage: $64m^2$
Volume of fresh air supply:
$600m^3/h$ (during heating / cooling)
Hot water tank: 300liter

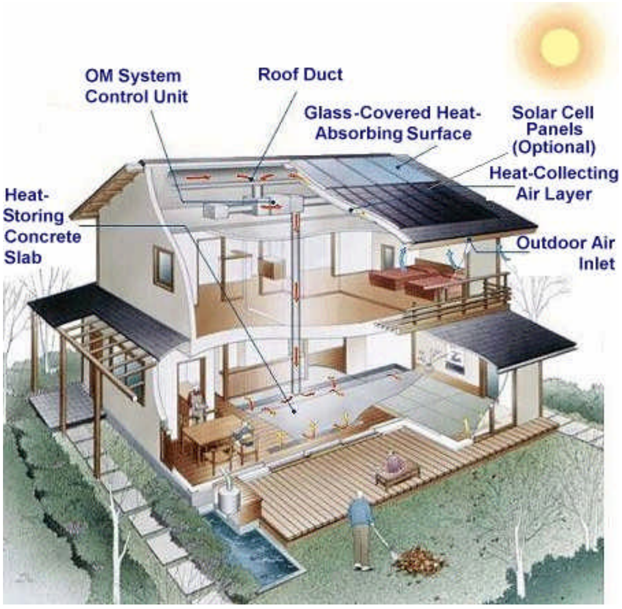
Building Specification
Total floor area: $116m^2$
K values: Roof $0.31W/Km^2$
Wall $0.59W/Km^2$
Floor $1.85W/Km^2$
Window $3.49W/Km^2$
Total equivalent leakage area: $2.4cm^2/m^2$
Heat loss coefficient: $2.71W/Km^2$

Section	***Insulation Specification***
Roof	Polystyrene foam 98mm
Wall	Polystyrene foam 50mm
Floor	Polystyrene foam 25mm
Window	Wooden sash, Double glazed

Technical systems

The OM Solar system operates on the principle of taking solar-heated air collected under the surface of a building's roof and channeling this hot air, via an interior vertical duct, down beneath the ground floor to a heat-storing concrete slab. This concrete slab warms the ground floor and releases hot air through floor vents for distribution throughout the building's interior spaces. Auxiliary devices come into operation for hot water supply and for backup heating on overcast or very cold days.

When external air exceeds a certain temperature, hot air collected under the roof's surface is expelled through an exhaust duct located directly under the roof without being circulated through the interior spaces.



The OM Solar system on a sunny winter day

The underfloor concrete slab, which as pure thermal mass saves heat in winter for release at night and on cloudy days, also serves to cool the house in summer by releasing, during the high-temperature daytime hours, the coolness it accumulates during the low-temperature nighttime hours.

Heat balance in an OM Solar house comprises three factors: heat collection, heat storage and insulation/air-tightness. Insulation and air-tightness are especially critical factors in providing energy-efficient and comfortable living conditions during winter, yet completely sealed structures are to be avoided because of the need for regular ventilation. A key feature of the OM Solar system is that it provides home occupants with continuous fresh air circulation.

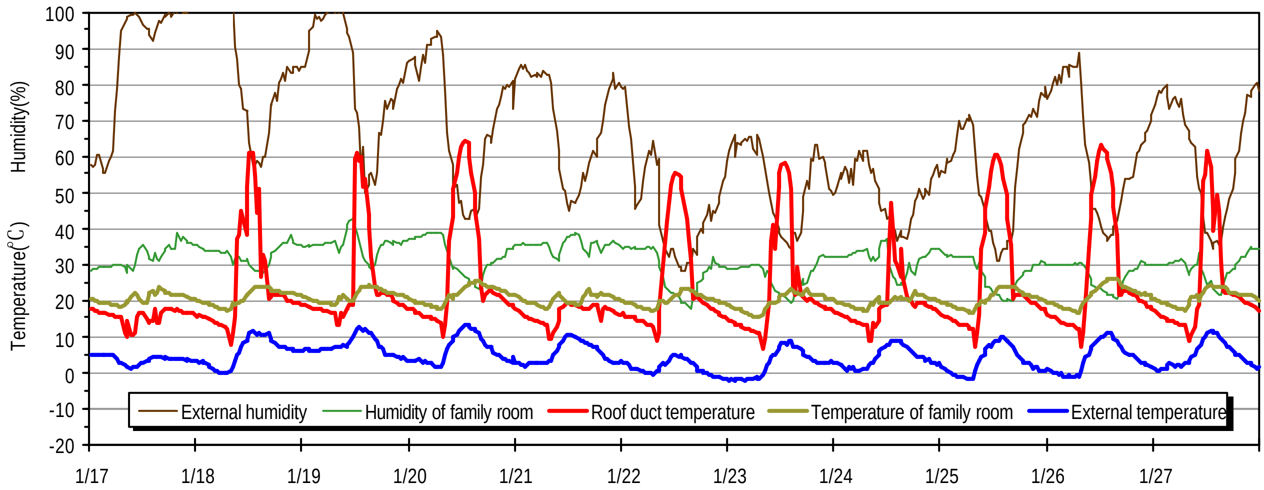
Planning tools for solar energy design, energy and thermal performance

OM computer simulation software "SunsonsV5" is used to design an OM Solar house before construction and the software was authorized as an heating/cooling load calculation software by the Institute for Building Environment and Energy Conservation (IBEC), Japan.

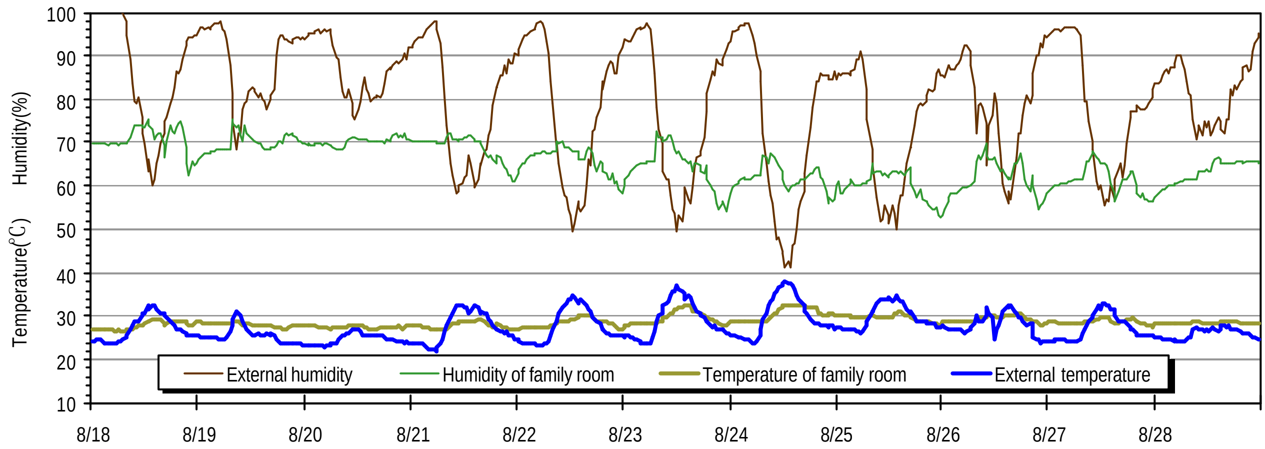
Thermal performance of the house

As shown in the top of the next page, on a clod day (Jan. 23) an outdoor morning temperature of -2°C gradually rose to a high of 8.5°C. The daytime temperature of the OM Solar heating air reached 60°C or so. As a result, indoor temperature was maintained at 15°C in the morning and rose to a high temperature of 23°C. On a cloudy day as Jan. 21, although the solar heat was not obtained, the room temperature was kept above 17°C. Note that this data was recorded in the coldest month for the year 2004.

On the other hand, the data collected in summer is also indicated in the middle of the next page. The difference between daytime and nighttime outdoor temperatures was more than 12°C. Under these conditions, the most effective way to maintain a comfortable interior temperature is to shut out external heat during the day by keeping the windows closed, and then to open the windows at night and/or bring external cool air into the interior through OM Solar system operation. On a hot day as Aug. 24, daytime outdoor temperature exceeded 35°C, while nighttime temperature dropped to 24°C. The room temperature was maintained at between 29°C to 32°C during the day long without resorting to an air conditioner.



Monitored data for a 11-day period in winter 2004



Monitored data for a 11-day period in summer 2003

Energy performance

The calculated heating load of the house for a year is given in the following table. It shows that 59% of the annual heating energy can be supplied by the solar heat (OM Solar system). An actual data of energy performance for a year is also listed in the following table. As an auxiliary heating system, a kerosene stove was used in this house. The gas was not used. The kerosene consumption for heating energy during a winter-period(Nov. 2002 to Mar. 2003) is about 548L that is equivalent to 3651Mcal(31.5Mcal/m^2).

Heating load calculated OM computer simulation software "SunsonsV5"

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Year	Ratio
OM Heating(Mcal)	419	543	513	474	739	505	3193	59%
Auxilairy Heating(Mcal)	0	387	930	731	153	19	2220	41%

Energy consumption recorded for a year from Nov. 2002 to Oct. 2003

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Year
Kerosene(L)	40	133	140	156	79	0	0	0	0	0	0	0	548
Electricity(kWh)	477	457	612	611	604	577	475	539	552	659	675	526	6764
Water(m^3)	24	23	23	20	22	23	24	25	25	27	29	29	294

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