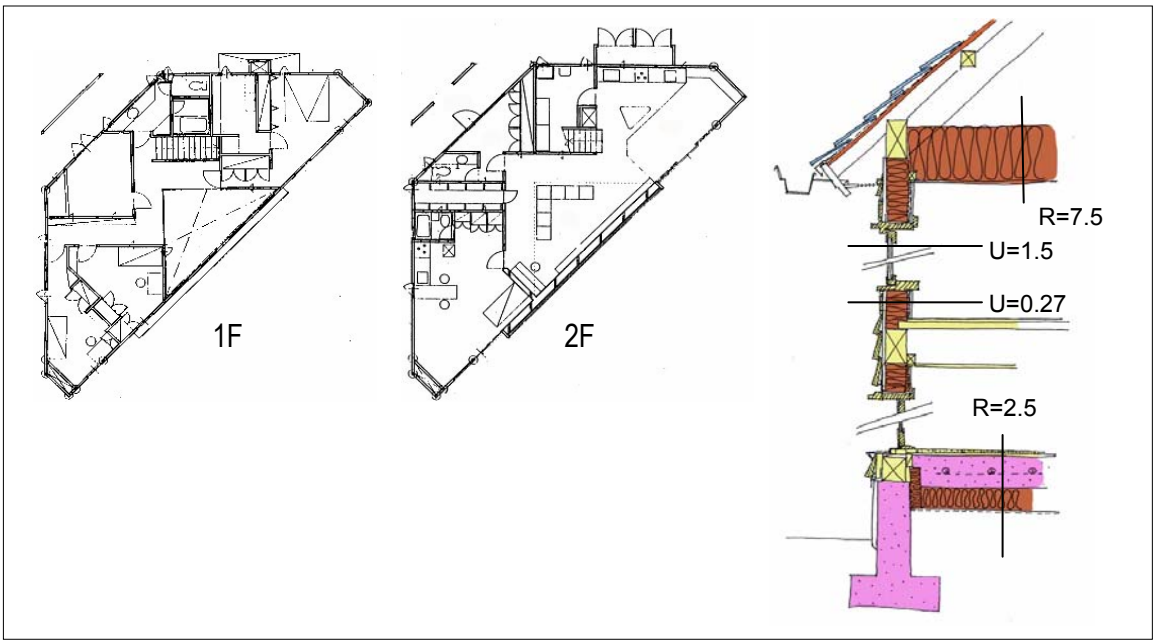
Chiryu, Japan

International Energy Agency

IEA – SHC Task 28 / ECBCS Annex 38:

Sustainable Solar Housing



The project

The Okamoto Solar House is in a semi-urban town of Chiryu, Japan. The town is close to Nagoya in the central part of the Japanese main island (on the pacific coast). This solar house is a single-family house in a residential district. The project was finished in February 2003.

The house has 3 bedrooms and an elder's room with kitchen and bathroom to make it possible to accept homecare. The kitchen and dining room is often used for cooking lessons and as a studio. The garden is a spiritual, secluded shelter in this crowded area.

Objectives

From the far past to the present, most Japanese houses have not been heated whether whole house or just during the winter - despite Japan having a cold winter carried down from Siberia. This custom has been the cause of various health and safety problems, for example dewing, ticks, allergy, asthma, heart attack, drowning in bathtub, etc.

Natural cooling, passive solar designs and active solar techniques are applied to this house to provide high quality of indoor climate through the year through whole house, whole season heating with same energy consumption compared to typical present day Japanese homes, in which, only a few rooms are heated or cooled as needed. Energy demand for domestic hot water occupies more than 1/3 of Japanese home energy, so DHW should be supplied by sun.

Marketing strategy

Seminars to educate the advantage of the solar house for people interested in the new home have been held more than 40 times a year throughout Japan, featuring the hybrid solar house "AMATELAS". Some 200 home builders are participating.

Building construction

Structure is by Japanese traditional "post and beam" method with 105mm thick wall cavity. To increase insulation thickness and minimize wooden cold bridges, vertical and horizontal bars are attached to make wall cavity thickness 140mm.

Exterior walls are insulated with cellulose insulation, U-value 0.27 W/m^2K.

Ceiling is 300mm cellulose insulated, R 7.5 m^2KW (0.13 W/m^2K).

Floor is slab-on grade, R 3.5 m^2KW (0.29 W/m^2K), solar heated heat-storage-floor is insulated with 100mm foamed polystyrene, R 2.5 m^2KW (0.4 W/m^2K).

Windows are double glazed, low-emission coated, argon filled, wood frame, total U-value of 1.5 w/ m^2K. Ventilation with heat recovery is not applied because of this rather mild climate but fresh air is drawn via cool tube to reduce ventilation loss.

Solar Collecters

Shutter/reflector for the Trombe wall

Technical systems

The house has a triangular plan with the widest wall facing true south to maximize solar gain in winter. The south roof has 45deg. tilt to provide maximum winter insolation to the solar collectors. Airlock entry and storages are arranged along north wall to be buffers for the living space.

Passive and active hybrid solar system for floor heating and DHW, named AMATELAS, is developed for this house. A micro-processor is central to AMATELAS and this system stores winter solar heat in the floor for radiant floor heating, makes hot water by excess solar heat, and activates auxiliary boiler when necessary. This makes AMATELAS the principal heating management system to integrate auxiliary boiler with the solar systems.

A 25m^2 trombe wall, widest in Japan, occupies the middle of the south wall, with a bi-fold R 2.5 (0.4W/m2K) insulated shutter and refractor, which is automatically operated responding to the intensity of the sun. The stainless steel surface of the shutter, when it is folded, reflects the sunlight to increase heat gain of the wall when it is needed, and when it is not needed it is closed to reflect summer heat.

Disconnected from city water, well water is used for domestic water demand, as well as space cooling for some parts of the house, especially for the bedrooms on tropical nights. Air conditioning is the primary cooling system with the major demand in the Japanese climate for dehumidification.

To provide good wind passages for either heated nor cooled season, casement windows are used for windows on east, north and west to provide both small window area and free flowing air passages.

Energy performance

The heating energy demand is reduced to 26% compared to a house with same floor plan and insulated according to 1999 building code of Japan (12% compared to 1992 building code). The houses under '92 building code are not heated whole house or whole winter, so this comparison makes no sense.

Total energy demand is reduced to 59% (40% compared to '92 building code)

Heating of space and ventilation air: 12.1 kWh/m²
Domestic hot water: 8.9 kWh/m²
(Energy source: Kerosene,
monitored total 22.2 kWh/m²)
Cooling of space and ventilation air: 10.8 kWh/m²
(Energy source: Electricity, COP 3.0,
monitored 4.5 kWh/m²)
Fans and pumps: 2.2 kWh/m²
Lights and appliances: 36.9 kWh/m²
(Energy source: Electricity,
monitored total 40.9 kWh/m²)
Total calculated energy demand: 70.9 kWh/m²
(Total monitored 69.6 kWh/m²)

•Degree Day (20-12) for heating : 1940
•Degree Day (18-18) for heating: 1840
•Degree Day (24-24) for cooling: -199

Planning tools

Energy demand simulation by SMASH and EESLISM.

Costs and benefits

The cost of the house is approximately 340,000 Euro, including costs for solar systems and other energy saving techniques. This is estimated 8-10% more expensive than a same house assumed to be built according to 1999 Japanese building code.

Innovative products

Space heating and DHW

Hybrid solar house system “AMATELAS”:

http://www.chiryuheater.jp

Envelope

Cellulose insulation: http://www.chiryuheater.jp

Windows: http://www.andersenwindows.com

Project team

Architect: Okamoto Yasuo (Chiryu Heater)
Contractor solar: Chiryu Heater
Builder: Kyowa Kensetsu

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