Combined Solar-Biomass Heating System for Row Houses

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Biomass is an attractive renewable energy source for space heating of buildings as well as auxiliary energy source for a *solar combisystem*. With a *combined solar-biomass heating system* the contribution to the heat demand of a building (space heat and hot water) is covered to 100% by renewable energy sources.

In Gleisdorf / Austria a combined solar-biomass heating system was installed in 1998 for an office building and 6 terraced houses; Figure 1 to Figure 3. The row houses are high insulated wood construction; Figure 4. Apart from optimising energy utilisation and cost efficiency, the development of an innovative and ecological wooden building concept forms an essential part of the project; Figure 2. As a result of a wall structure developed specially for this type of house, it was possible to attain the heat insulation demand (u = 0,11 W/(m², K)) in a cost efficient and space saving manner. Moreover, with this wooden building system a considerable amount of pre-fabrication was possible; Figure 5. Another advantage is offered by the wall and ceiling structure which is completely free of thermal bridges.

As a result of the high heating insulation standard, thermal zoning and controlled air ventilation using ground heat exchangers it was possible to reduce the heating energy requirement of these buildings by 60% compared to the present new building standard: about 30 kWh/(m², a); Figure 6.

The collectors with an extension of 230 m² were integrated into the roofs of the winter gardens and cover 80% of the hot water and 60% of the space heating demand of the whole year. The remaining energy is provided by a biomass (pellets) boiler; Figure 7. The heat demand for the building is met 100% by renewable sources of energy.

The buildings were equipped with special low-temperature wall heating systems. The medium fluid temperature of low-temperature wall heating system is 35 °C during the heating period.

The individual houses are supplied by a central 14 m³ storage tank via a local 2-pipe heating network with decentralised heat storage in the row houses; Figure 8. The network is operated over 22 hours a day at a low temperature level (40°C) (heating operation). To prepare the hot water the same local heating network is operated during the night for two hours at a higher temperature level (65°C - 70°C). In this time the heating is switched off and only the decentralise warm water storage tanks are loaded.

With due consideration to the higher heat insulation standard of the building envelope, the passive use of solar energy and the internal gains, the heating energy requirement was ascertained in accordance with the simulations carried out with TRNSYS as 26 kWh/(m², a) for the office building and 32 kWh/(m², a) for the terraced houses. In the first heating season in 1998/99 the actual heating energy consumption in the office building was 20 kWh/(m², a). Of this 60% was catered for by the solar plant so that the remaining heating energy requirement, which was met by a pellets boiler, only equalled some 8 kWh/(m², a). In reality it was possible to clearly undercut the values ascertained during the simulation.

To complete the overall solar concept, a grid connected photovoltaic plant with a performance of 1.4 kW produces one part of the electricity demand.

The annual energy balance for the housing estates is shown in Figure 9 and Figure 10.

The average (1999 – 2001) annual space heating demand for the office building was 17,46 kWh/(m², a) . Since 65,67 % (average of the three years) of the space heating demand was covered by solar energy, the remaining average residual energy requirement of 6 kWh/(m², a) for the office building was covered by the automatic biomass pellet-boiler.

The average (2000 – 2001) annual space heating demand for one terraced house was 34,57 kWh/(m², a). Since 68 % (average of 2000 and 2001) of the space heating demand was covered by solar energy, the remaining average residual energy requirement of 11 kWh/(m², a) for the terraced house was covered by the automatic biomass pellet-boiler.

The overall energy requirement for the office building, including space heating, hot water, electricity and electrical energy for pumps ("parasitic" energy) equalled 55 kWh/(m², a) in 1999, 60 kWh/(m², a) in the year 2000 and 76 kWh/(m², a) in the year 2001.

The increase of the overall energy consumption is due to the increase of the electricity consumption because of an increase of employees and more computers and office equipment used.

The yield of the solar collectors was slightly (5,5%) lower than expected. The design value was 200 kWh/(m², a) with a solar fraction of 53%. The measured value (2001) was 189 kWh/(m², a) with a solar fraction of 60%.

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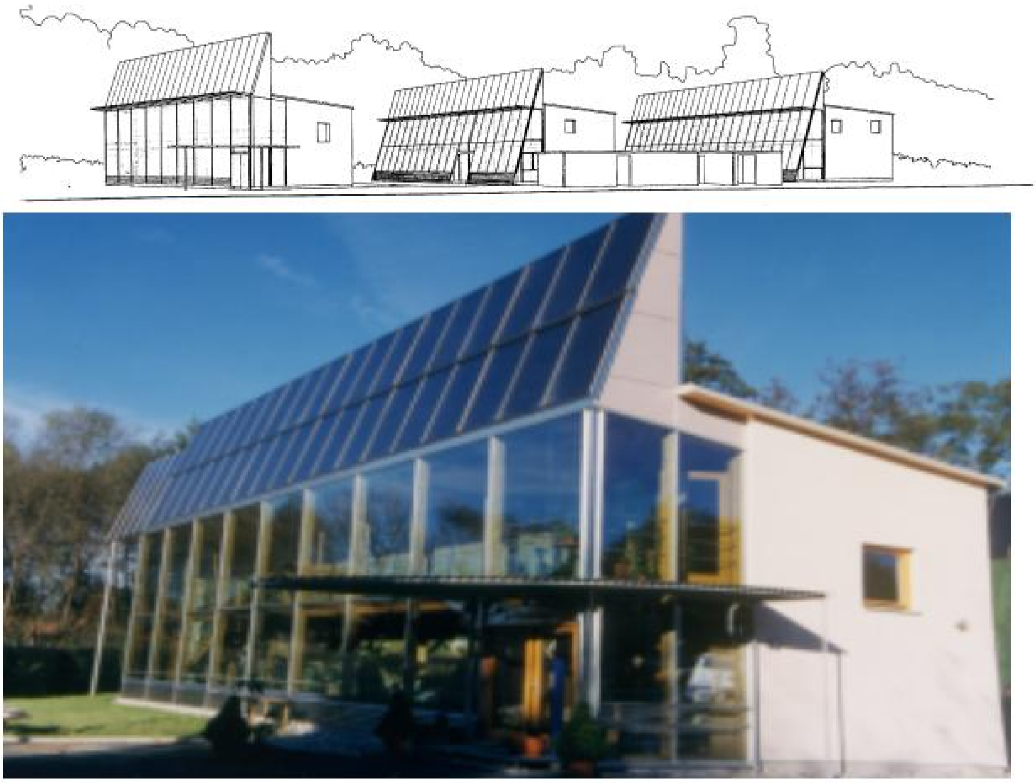

Fig. 1: Housing estate „SUNDAYS“

Fig. 2: Housing estate „SUNDAYS“

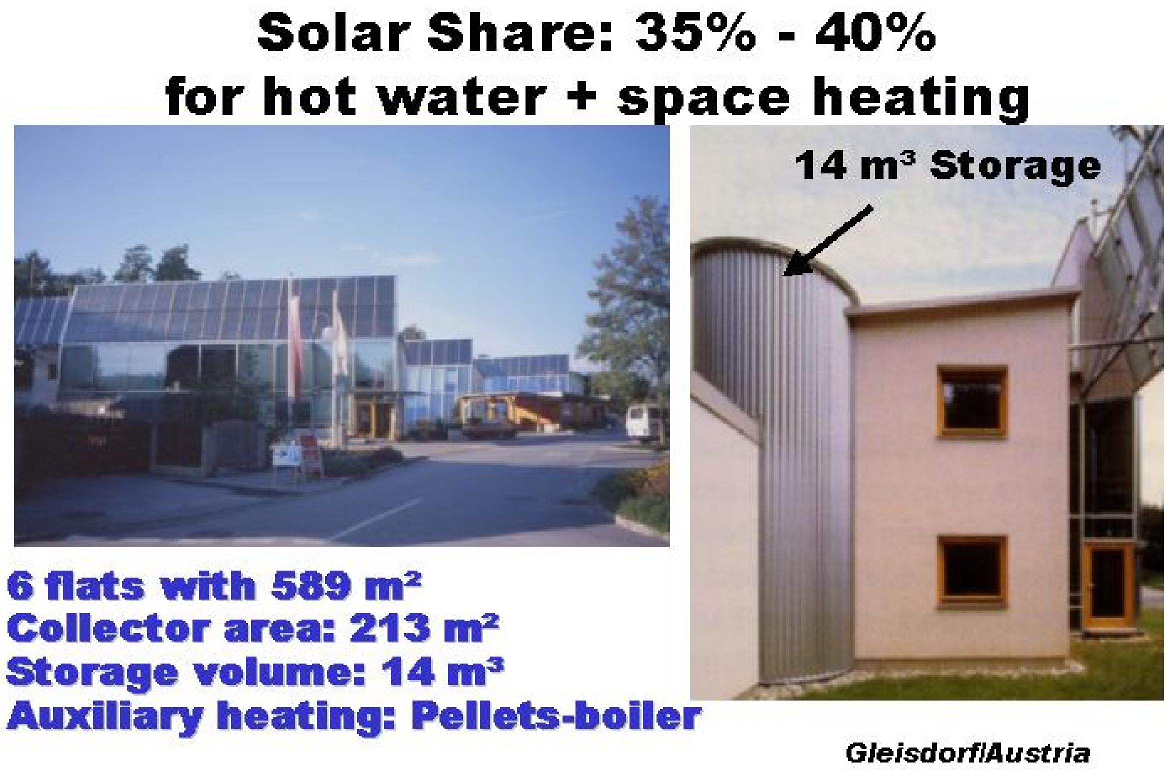

Fig. 3: Design data

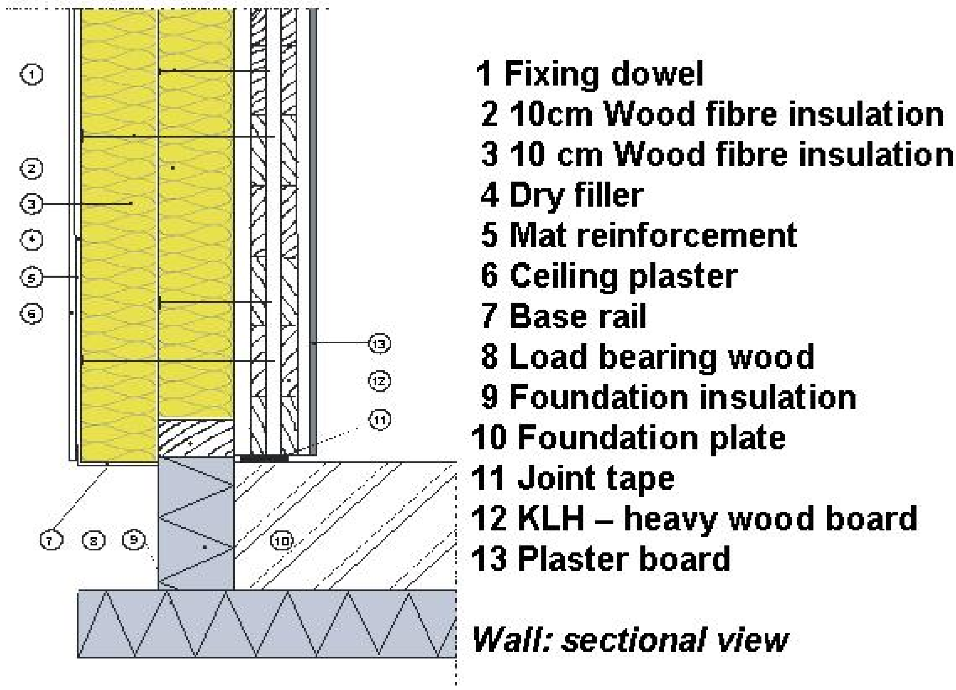

Fig. 4: Building construction: Outside wall

Fig. 5: Building construction phase

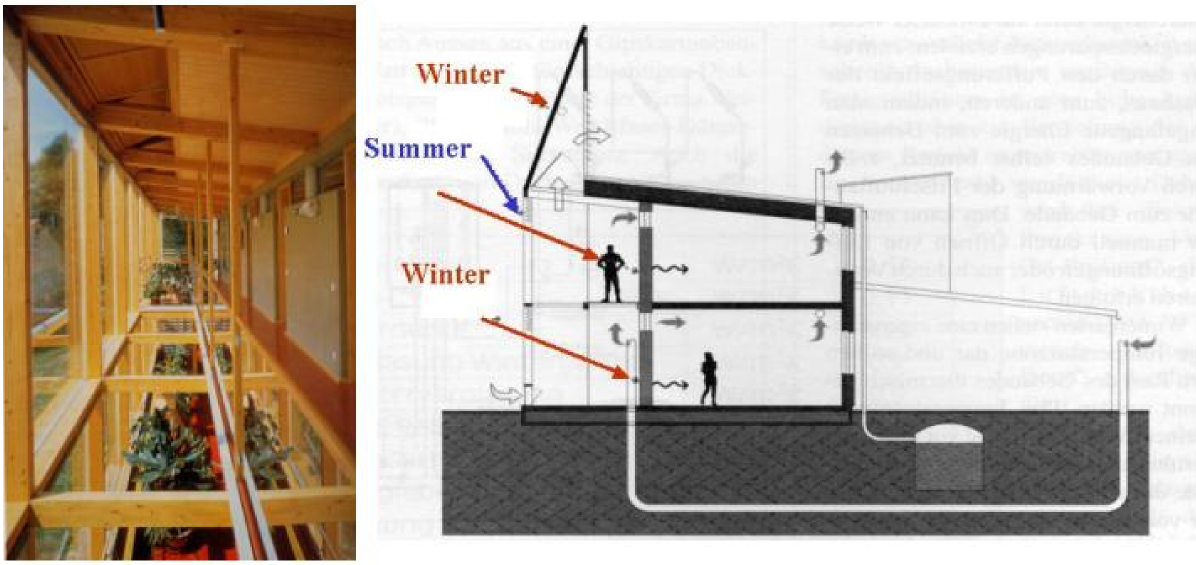

Fig. 6: Natural cooling of winter garden

Fig. 7: Central heating with pellets

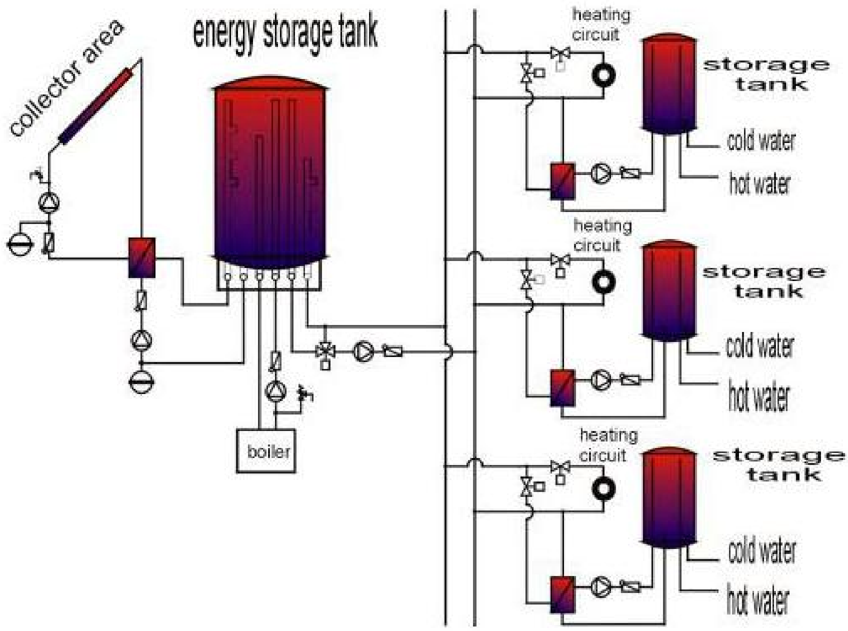

Fig. 8: Solar thermal system with central storage in combination with decentralised hot water storages: 2-pipe net

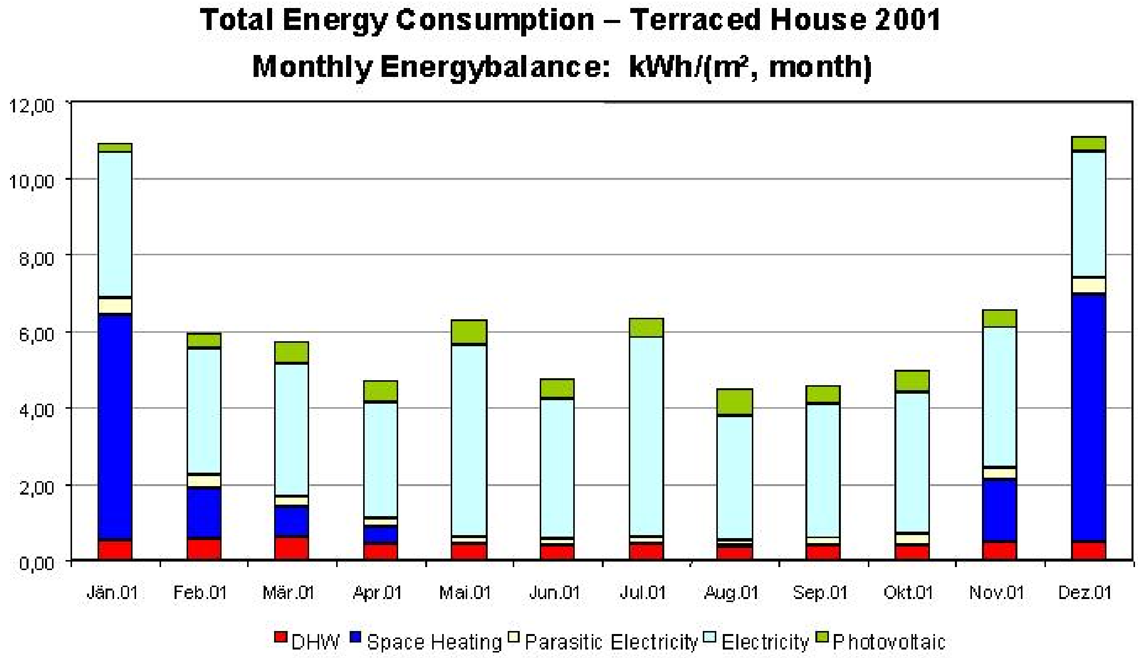

Fig. 9: Monthly energy balance of terraced house: 2001

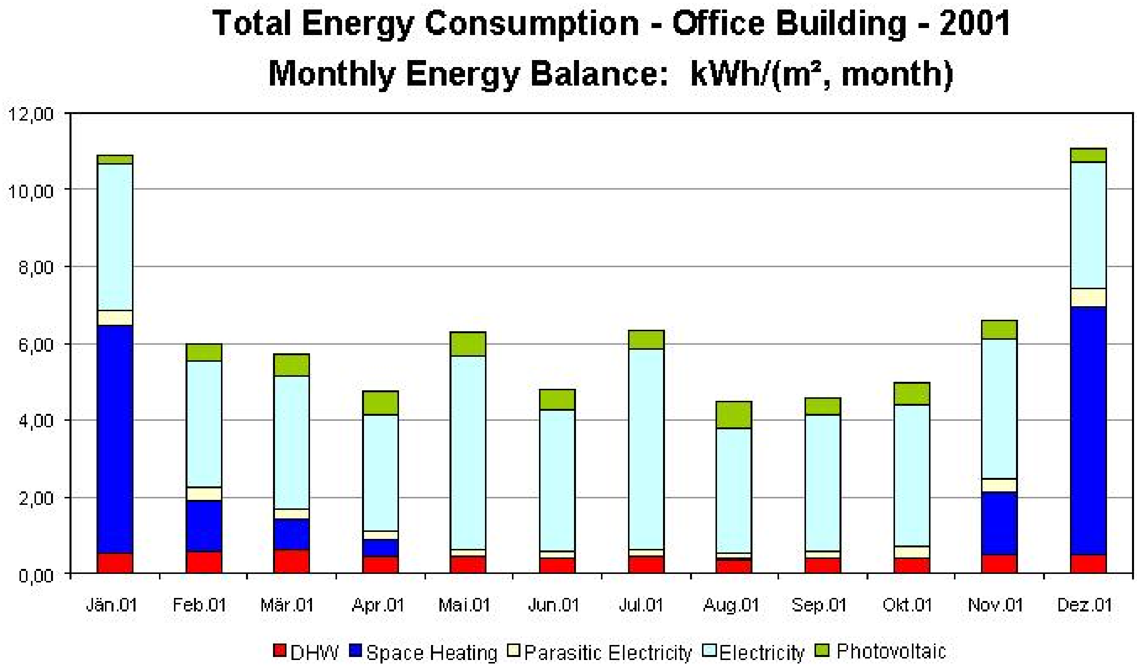

Fig. 10: Monthly energy balance of office building: 2001