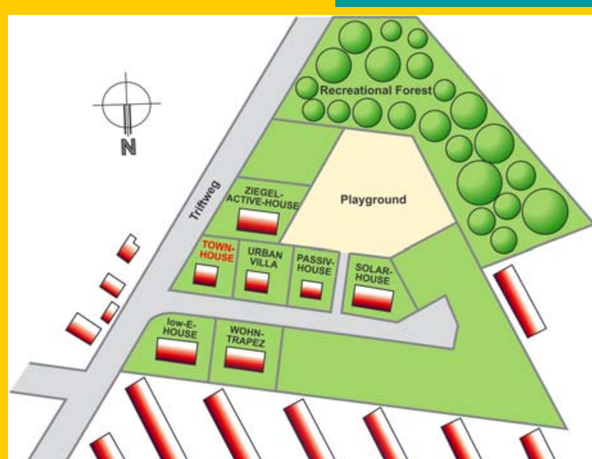
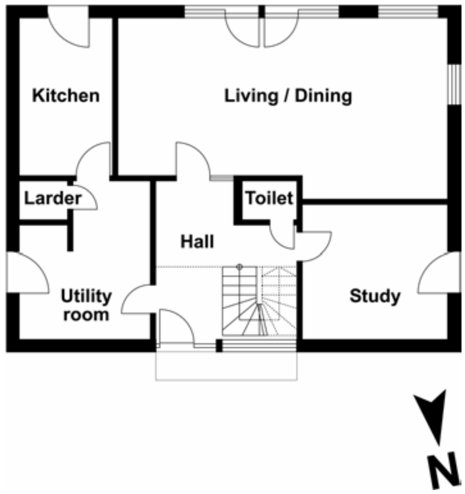
3-Litre Townhouse
Celle, Germany

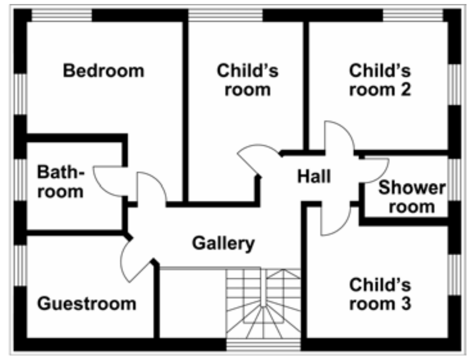


INTERNATIONAL ENERGY AGENCY

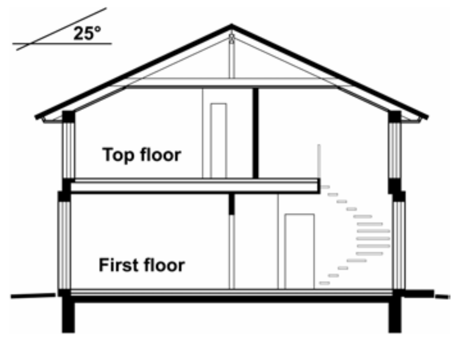
IEA-SHC Task 28 / ECBCS Annex 38:

Sustainable Solar Housing





Building characteristics	
Building volume V_e	654 m³
A/V	0.70 m^{-1}
Usable floor area A_N	209 m²



The Project

The detached single-family house was built in a newly developed area at the outskirts of Celle in 2001. The city of Celle is located about 30 km north of Hanover. To the south, this developing area abuts upon a recreation forest, and to the north upon an existing residential area. The 1 ½ storey building has a surface-to-volume ratio A/V of 0.70 m^{-1} and a usable floor area A_N of 209 m². The living room, the study, the kitchen, and the utility room are located on the ground floor. The top floor hosts five rooms and a bathroom. The building was raised by a major local manufacturer of prefabricated buildings as a lightweight timber construction.

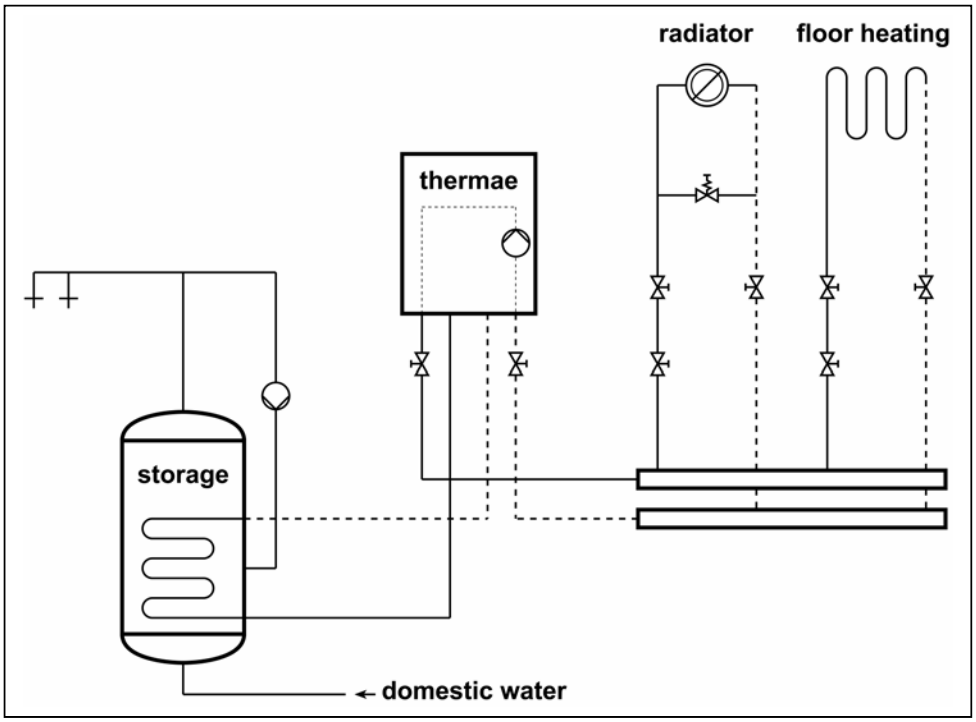
Objectives

The manufacturer of this prefabricated house is expecting a growing demand for residential buildings with an extremely low energy demand in the near future. This is

why the company developed this prototype building, designated 'Townhouse', as a 3-litre house. Low-energy buildings with an annual primary energy demand of less than 34 kWh/m²a for heating (inclusive of auxiliary energy for pumps and fans) are referred to as '3-litre houses'. This corresponds to the primary energy content of 3 litres of heating oil. To succeed in a competitive market, strict economic criteria had to be obeyed when developing the house. In future, the manufacturer will distribute this type of building all over Germany.

Building construction

The exterior walls are lightweight timber stud structures. The mineral-fibre insulation layer inserted between the vertical timber studs is 200 mm thick. An additional 85 mm polystyrene insulating layer was applied to the outside of the wall. This layer was plastered in the ground floor area, but sheathed with timber in the top floor area.



The wall has a U-value of 0.15 W/m²K. The roof was insulated with a 240 mm mineral-fibre layer between the rafters (U = 0.18 W/m²K). The building has no cellar. The concrete floor slab of the building was provided with a 120 mm rigid-foam insulation board below the screed (U = 0.31 W/m²K). The wooden windows have a double thermal insulation glazing (U_W = 1.6 W/m²K); the interspace is filled with argon gas. The total energy transmittance of the glazing is equal to 0.58.

To ensure air tightness, a polythene sheet was applied to the internal side of the walls. The outside of the walls was provided with a roofing membrane; all junctions were hermetically sealed. The air tightness n_{50}, which was determined in a blower-door test, amounts to 0.65 h^{-1}.

Technical systems

The heat required for townhouse space heating and domestic hot water is generated by a gas-condensing water heater, which can be operated between 3.5 and 11 kW. The heat is distributed to the spaces of the house by means of a single-room controlled, water-bearing floor heating system on the ground floor, and through radiators located on the top floor. There is an individual space heating control in each room with underfloor heating. The spaces are equipped with indoor-air temperature sensors that control the servomotors of the heating circuits, thus influencing the throughput of water. In the other radiator-heated spaces, the indoor-air temperature is controlled by means of thermostatic valves.

The necessary air change is ensured by means of a balanced ventilation system (with heat recovery). This system is provided with a high-efficiency counterflow heat exchanger. Re-heating of the supply air was therefore considered unnecessary. As a rule, the ventilation system is run at stage 2. Depending on demand, the system can be manually switched to setback operation (stage 1) or to intensive ventilation (stage 3). There is also a time-programme that allows the fan stages to be timed in advance.

The domestic hot water is heated in a 300-litre storage tank by the gas condensing water heater. The entire technical systems were installed in the utility room on the ground floor.

Energy performance

The calculated primary energy demand for heating amounts to 26.9 kWh/m²a. This value includes the auxiliary energy required for heat generation and heat distribution. The ventilation system has a primary energy demand of 6.6 kWh/m². The total primary energy supply for domestic water heating is equal to 32.8 kWh/m²a. The calculated primary energy demand for heating and venting is

33.5 kWh/m²a. This corresponds to the primary energy content of 3 litres of heating oil per m² and year. The total primary energy supply for the building amounts to 66.3 kWh/m²a; this value is about 40 % less than the permissible value of 110 kWh/m²a that is specified in the current German regulations on energy conservation (EnEV)

Consumption	Final energy [kWh/m²a]	Primary energy [kWh/m²a]
Heating	21.6	26.9
Ventilation	2.2	6.6
DHW	28.3	32.8
Total	52.1	66.3

Planning tools

The energy demand for heating, ventilation and domestic hot water was computed by way of the calculation routine that is applied in order to verify the energetic requirements specified in the German regulations on energy conservation (EnEV).

Costs

The sales price for the ready-for-occupancy prefabricated house amounts to € 268,600. This price does not include the costs for the foundations.

Innovative products

Ventilation:
Heat recovery unit: www.jestorkair.nl

Space heating and DHW:
Condensing boiler: www.junkers.com

Financing

The elaboration of the concept was funded by the German Federal Ministry of Economics and Labour (BMWA).

Project team

Manufacturer of the prefabricated building:
Haacke + Haacke GmbH + CO. KG,
Am Ohlhorstberge 3, D-29202 Celle

Architect:
Dr. Stauth, Braunschweig

Evaluation of the concepts and performance of the monitoring programme:
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Literature

Reiss, Johann; Erhorn, Hans: The Celle 3-litre-house - validation by measurements IBP Report WB 123 (forthcoming).