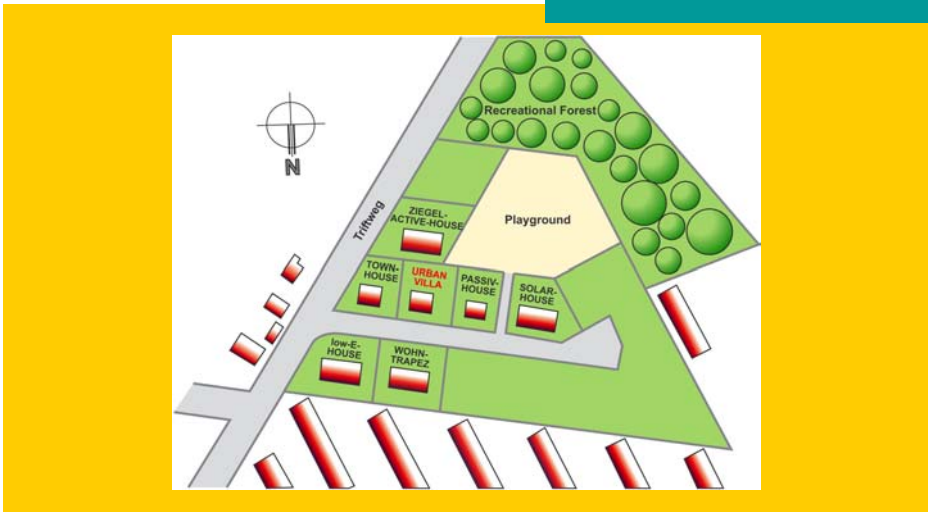
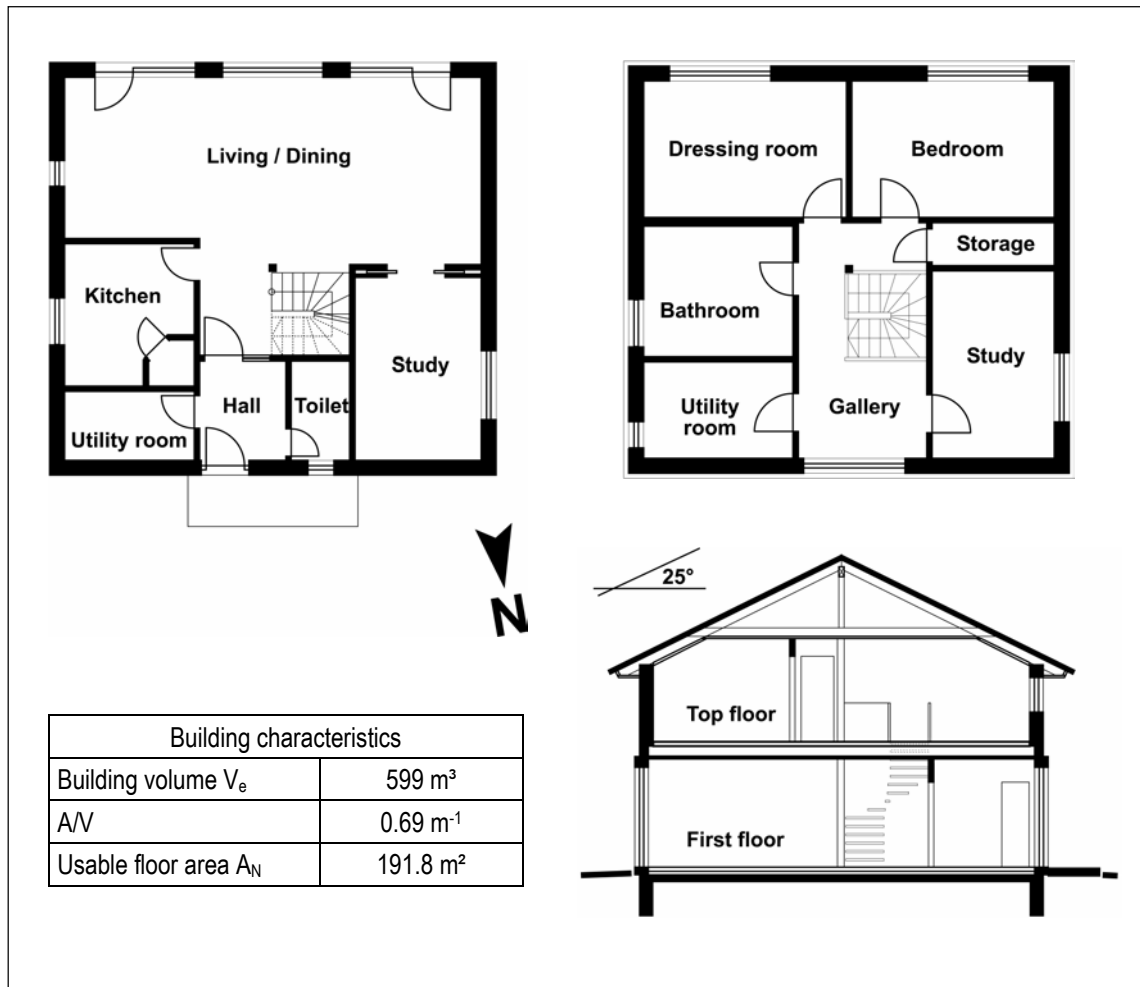


## 3-Litre Urban Villa Celle, Germany



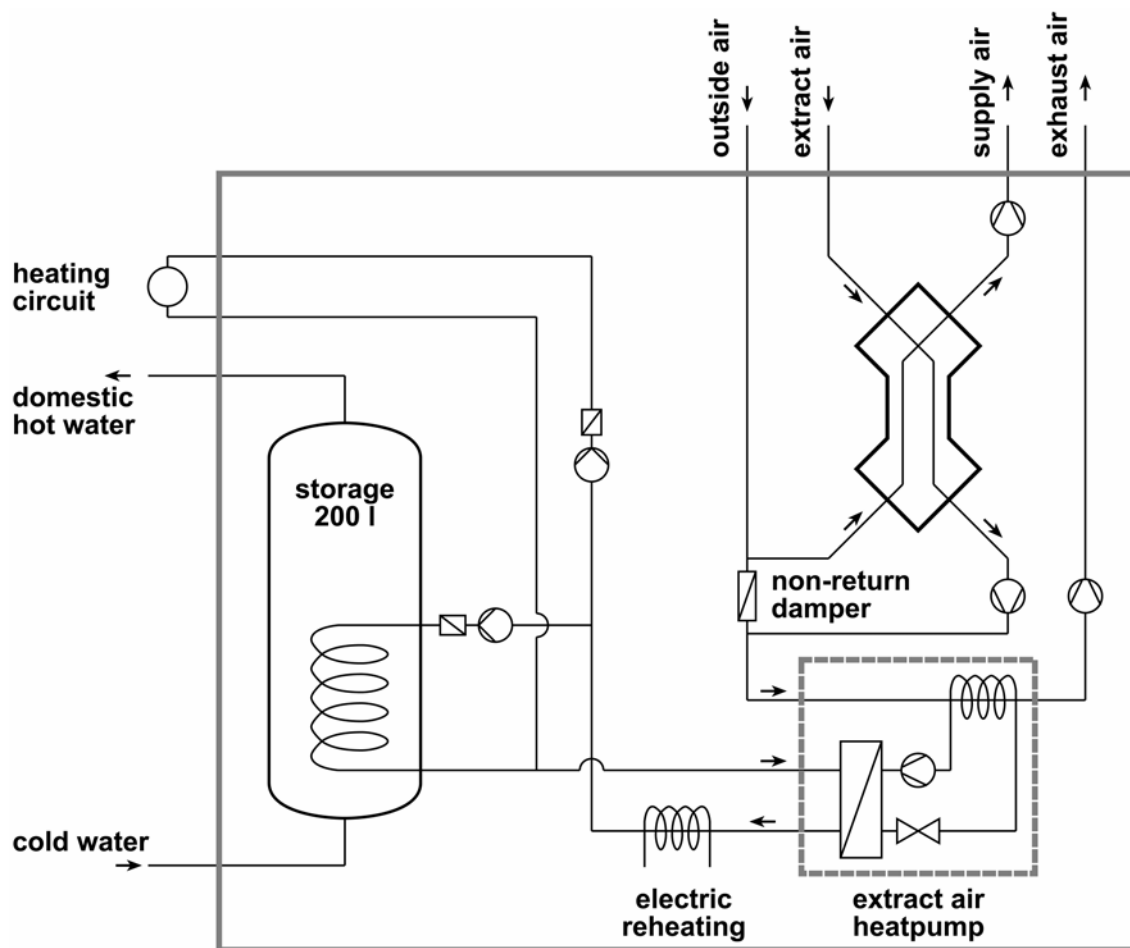


### The project

The detached, single-family house was raised in 2003. It is situated in a newly developed area at the outskirts of Celle. The city of Celle is located about 30 km north of Hanover. To the south, the developing area abuts upon a recreation forest and to the north upon an existing residential area. The one-and-a-half-storey building has a surface-to-volume ratio  $A/V$  of 0.69 m<sup>-1</sup>. The usable floor area  $A_N$  amounts to 191.8 m<sup>2</sup>. The ground floor hosts the living room, the kitchen, a study and a housekeeping room; on the top floor, there are a bathroom, another housekeeping room and three more bedrooms. The building was raised by a 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 'Urban villa', as a 3-litre house. Low-energy buildings with an annual primary energy demand of less than 34 kWh/m<sup>2</sup>a 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 60 mm insulating level with a mineral wool infill was applied on the inside. In the ground floor area, the external face of the wall was covered with cleaving tiles; in the top floor area, it was covered with profiled timber. The roof was insulated with a 240 mm mineral-fibre layer between the rafters ( $U = 0.14 \text{ W/m}^2\text{K}$ ); below the rafters, there is a 60 mm layer of mineral wool. The building has no cellar. The floor of the building was provided with a 120 mm rigid-foam insulation board both above and below the concrete slab ( $U = 0.15 \text{ W/m}^2\text{K}$ ). The windows were provided with passive house frames and have triple thermal insulation glazing ( $U_w = 0.8 \text{ W/m}^2\text{K}$ ); the space between the panes was filled with argon gas. The total energy transmittance of the glazing is equal to 0.55.

To ensure air tightness, a polythene sheet was applied to the internal side of the walls; externally, a roofing membrane was fixed to the walls, which was hermetically bonded at the junctions. The air

tightness  $n_{50}$ , which was determined in a blower-door test, amounts to  $0.85 \text{ h}^{-1}$ .

### Technical systems

In the 'Urban villa', a compact device with a heat pump is charged with all the tasks of energy supply, i. e. centralised balanced ventilation, DHW and space heating. The essential components of the device include: extract air heat pump, crossflow/counterflow heat exchanger and DHW storage tank. The exhaust air is extracted from the wet rooms to be conveyed through a crossflow/counterflow heat exchanger, which transfers the heat gained in this way to the intake air. A heat pump that was installed in the extract airflow draws more heat from the exhaust air and supplies it to the 200-litre DHW tank and the heating system. As a heat pump is more efficient at lower temperatures, the spaces of the 'Urban villa' were provided with a floor heating system. The supply air will not be heated after having passed the cross/counterflow heat exchanger. Before entering the evaporator, the extract airflow can be mixed with outside air. In case of very high heat demands for space heating or

domestic hot water, direct electrical supplementary heating is possible.

### Energy performance

The final energy demand for heating and ventilation amounts to 6.1 kWh/m<sup>2</sup>a; the demand for domestic hot water is 6.6 kWh/m<sup>2</sup>a. These figures refer to electrical energy. Accordingly, the primary energy demand results to 18.3 kWh/m<sup>2</sup>a and to 19.9 kWh/m<sup>2</sup>a, respectively. With a value of 38.2 kWh/m<sup>2</sup>a, the total primary energy demand of the building is about 65 % below the permissible value of 110 kWh/m<sup>2</sup>a that is specified in the current German regulations on energy conservation (EnEV).

Consumption	Final energy [kWh/m <sup>2</sup> a]	Primary energy [kWh/m <sup>2</sup> a]
Heating	6.1	18.3
Domestic hot water	6.6	19.9
Total	12.7	38.2

### Planning tools

The energy demand for heating and preparation of domestic hot water was computed in accordance with the German calculation standards DIN 4108 part 6 and DIN 4701 part 10, as specified in the German regulations on energy conservation (EnEV).

### Innovative products

Compact device for heating, ventilation, and domestic water heating:

[www.tecalor.com](http://www.tecalor.com)

### Financing

The evaluation of the energy concept was funded by the German Federal Ministry of Economics and Labour (BMWA), Berlin.

### Project team

Manufacturer of the prefabricated building:  
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Architect:  
Dr. Stauth, Braunschweig

Design evaluation and performance of the monitoring programme:  
Fraunhofer Institute for Building Physics (IBP), Stuttgart.

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### Literature

Reiss, Johann; Erhorn, Hans: Messtechnische Validierung der 3-Liter-Haus-Stadtvilla in Celle [The Celle 3-litre urban villa - Validation by measurement]. IBP report (forthcoming).

[www.iea-shc.org](http://www.iea-shc.org)

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