Demonstration Houses in

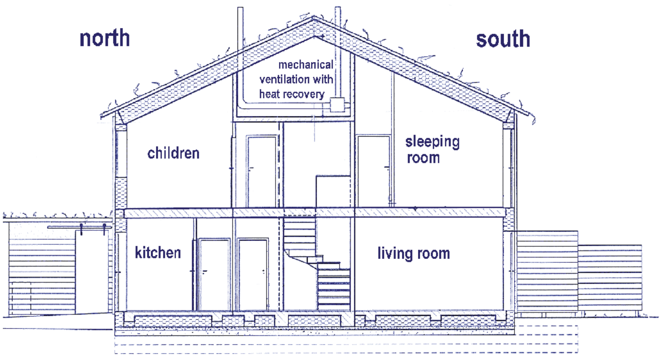
Hannover-Kronsberg, Germany

International Energy Agency

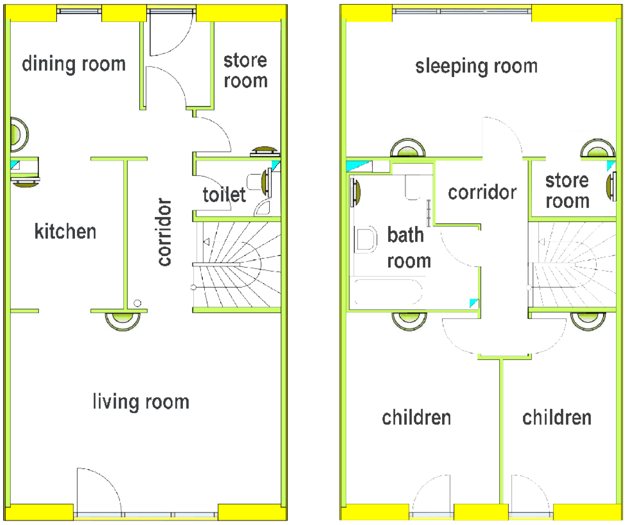
IEA – SCH Task 28 / ECBCS Annex 38:

Sustainable Solar Housing

view from south, roofs with solar collectors and low intensity planting



cross section, view from west



horizontal projection
supply-air and exhaust-air valves are indicated

Passive House standard

The conception of passive houses was developed in the late eighties. Meanwhile the super insulated houses with mechanical ventilation and heat recovery proofed to provide high thermal comfort with extreme low specific heat energy consumption of about 15 kWh/(m^2a). This is an energy conservation of about 75% compared to conventional buildings.

The project

The 32 terraced houses in Hannover Kronsberg are arranged in four rows with eight houses each row. This arrangement offers the advantage of reduced envelope surface area to volume ratio. The houses are type buildings which are available in three sizes with 79, 97, and 120 m^2 floor area respectively.

The main intention of this project was to show, that heat supply in passive houses can be realized by warming up the supply air of the balanced ventilation system. So these houses have no conventional heating system with radiators, except one in the bathroom.

The houses were built by a construction contractor to be resold for private use. The intention was to provide room for young families. The dwellings were partially funded by the Community of Hannover.

The Passive House Project in Hannover Kronsberg was a registered EXPO 2000 project (Cost efficient Climate Neutral Passive Houses, Reg. No. NI244).

Construction

Walls and roofs are made of light-weight wooden construction with U-values of U_{wall} = 0.13 W/(m^2K) and U_{roof} = 0.10 W/(m^2K). The core of the building, the cross-walls and end-walls are made of prefabricated concrete elements. This modular construction allowed cost reduction, so it was possible to achieve pure building costs that are as low as for conventional buildings.

Good airtightness of the building envelope is an essential precondition for passive houses. Many details of the construction had to be revised to fulfill the augmented specifications e.g. flash strips to join up window-frames to the wall are necessary. The airtightness was checked by means of a "blower door test", and reached a residual air change rate at 50 Pa of n_{50} = 0.3 ac/h in average.

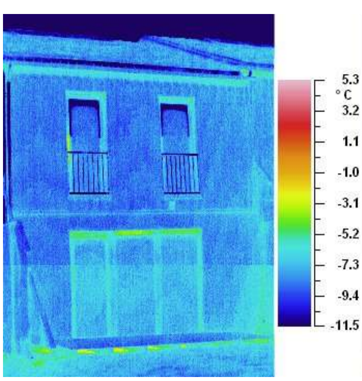
Installations in each row house:
Left: Solar hot water storage and supply-air heater (SAH).
Right: Mechanical ventilation system with heat recovery.

Controlled mechanical ventilation with heat recovery requires air- tightness

The passive house conception includes controlled air supply and exhaust-air extraction with heat recovery. The above mentioned excellent air-tightness of the building envelope is an essential pre-condition to the passive house standard, so that all the air change for ventilation takes place via the high-efficient counterflow air-to-air heat exchanger with a heat recovery rate of 80 %. Ventilation heat losses are thus reduced significantly.

The controlled ventilation system supplies the dwelling rooms all around the clock with fresh air warmed up in the heat exchanger. The inhabitants MAY open doors and windows, but they DO NOT NEED to accomplish ventilation through windows during the heating period. The length of the air ducts was designed to be as short as possible for architectual as well as for cost and efficiency reasons (pressure drop and heat losses).

The heating of the building during the heating period (November to March) is performed by a supplementary water/air heater placed after the heat recovery, which heats up the supply air. The only servicable part of the ventilation system are the air filters, which have to be changed regularly. Artificial humidification of air is not necessary. If humidity of air drops too low in winter, the inhabitants are advised to reduce the air exchange rate below the designed value of 120 m^3/h.



Infrared thermography test

Enery supply system

All houses are connected to a grid of district heat supply which is fed by a combined heat and power machine. In addition flat plate thermal solar collectors and a thermal storage tank in each house are used for domestic hot water production in summer.

The connection to the grid is implemented separately for two rows of eight houses each respectively. All houses are connected via a heat load line from the connector. This line supplies the hot water tank of the solar thermal system in each house, if not enough heat from the sun is available. Moreover it supplies the water-to-air heater to provide space heating.

Househould appliances

Almost all dwellings are equipped with dish-washer and the washing machine connected to the domestic hot water supply to avoid electrical heat production as much as possible. All inhabitants were advised to provide their households with energy saving electric appliances e.g. light, cooling and freezing, dish-washer, and washing machine. With the aid of a questionnaire the energy-saving potential was evaluated. The use of low energy appliances was funded by a repayment by the construction contractor.

Passive solar gains and shading in summer

Most passive houses have its main windows directed to south, so daylighting is provided by direct solar radiation most time of the day. In winter, solar gains through windows cover about one third of space heating energy demand.

In summer, a manual-driven shading system protects the rooms from too high temperatures. Besides this, the high-quality thermal insulation in combination with the large internal masses (concrete) help to keep the temperatures in summer on a moderate level, if cross ventilation during the night is applied.

Costs

Modular construction of terraced houses and multi-storey flats allow to achieve pure building costs that do not extend the costs of conventional buildings. This type of construction offsets the extra expenditure for insulation and ventilation system almost completely. Modular construction means a high degree of prefabrication of the various structural elements, a low number of different elements with improved quality, sophisticated logistics and a short construction time. This cost reduction provides for a broad introduction of passive houses into the market.

Planning tools

The planning process of passive houses is assisted by the PHPP (passive-house-planning package). This is a spreadsheet calculation tool, which is based on the EN 832. Some calculations and assumptions, such as air-tightness, heat-recovery, internal gains, solar gains and shading etc. are treated more sophistically. The reason for this is, that some assumptions in national standards are not valid with respect to passive houses. It is essential in this case to calculate with higher accuracy to get reasonable results. The PHPP is available at Passive House Institute (see below).

Scientific research studies

Within the CEPHEUS project (Cost Efficient Passive Houses as European Standards) funded by the European Commission, the temperatures and heat energy consumption was measured to show the reliability of the passive-house conception. See the following publications:

Feist, W., Peper, S., Oesen, M., CEPHEUS-Projektinformation Nr. 18, Klimaneutrale Passivhaussiedlung Hannover-Kronsberg, published by the Stadtwerke Hannover, 2001.

Peper, S., Feist, W., Kah, O., CEPHEUS-Projektinformation Nr. 19, Klimaneutrale Passivhaussiedlung Hannover-Kronsberg, Meßtechnische Untersuchung und Auswertung, published by the Stadtwerke Hannover, 2001.

Kaufmann, B., Feist, W., Vergleich von Messung und Simulation am Beispiel eines Passivhauses in Hannover-Kronsberg. CEPHEUS Projektinformation Nr. 21, published by the Stadtwerke Hannover, 2001.

Schnieders, J., CEPHEUS – Wissenschaftliche Begleitung und Auswertung, Endbericht, CEPHEUS Projektinformation Nr. 22, Passivhaus Institut, Darmstadt, 2001, see as well at www.cepheus.de

Peper, S., Feist, W., Klimaneutrale Passivhaussiedlung Hannover-Kronsberg. Analyse im dritten Betriebsjahr. Endbericht im Auftrag der Stadtwerke Hannover. Darmstadt, April 2002.

Danner, M., Institut für Umweltkommunikation, Universität Lüneburg, Nutzererfahrungen in der Passivhaussiedlung in Hannover-Kronsberg. Contribution to the 7. International Passive House Conference, Hamburg 2003, Conference Proceedings in German, Passivhaus Institut, Darmstadt, 2003

A further CEPEUS publication in english is available from Stadtwerke Hannover.

Illustrations: The cross section and horizontal projections originate from the architects Rasch & Partner, see below. All photographs PHI.

Architects: Rasch & Partner, Volkmar Rasch and Petra Grenz, Steubenplatz 12, 64293 Darmstadt

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