Passiv houses in Frankfurt/Main – building the future

www.energiereferat.stadt-frankfurt.de

www.energiemanagement.stadt-frankfurt.de

STADT FRANKFURT AM MAIN

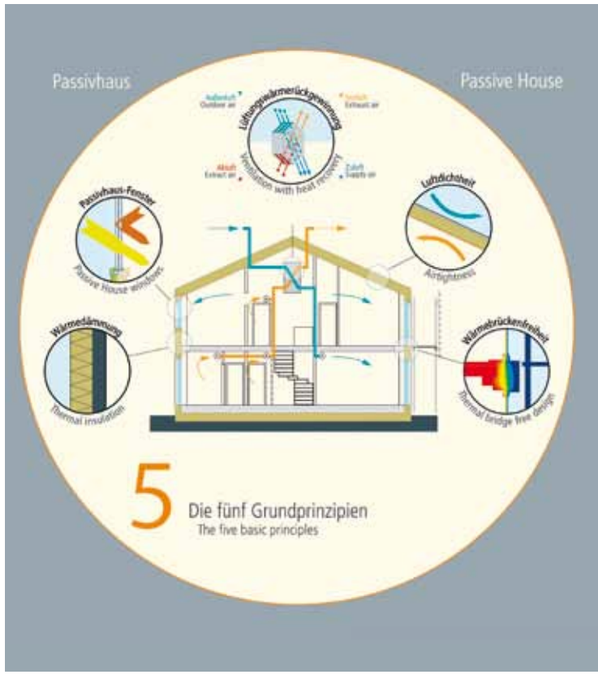
Frankfurt/Main frontrunner in passive house construction

On 6 September 2007, the city parliament passed a resolution stipulating passive house standards for all new buildings, thereby corroborating the pioneering role played by the city of Frankfurt/Main in the German energy transition.
A further ground-breaking step followed in 2010 when a landmark decision in favour of passive house specifications for all city-owned buildings was passed. The parliament also stipulated that city properties may not be sold unless the respective building projects comply with passive house standards. Frankfurt's public works department and ABG Frankfurt Holding assumed a ground-breaking role within Germany. The variety of passive buildings constructed by the public works department ranges from schools to day-care centres and passive house components in building refurbishment. As early as 2006, the municipal housing and real estate group ABG undertook to construct all new buildings according to passive house standards.
Furthermore, the city set up passive house subsidy programmes to create financial incentives for property developers. Housing development subsidies have been linked to the building design, for example in social housing and student residences. Under further programmes, builders receive subsidies if they opt for passive house standards in projects such as family and senior citizen housing developments. Refurbishments in passive house quality also qualify for subsidies of the city.
Noticeable results were already achieved in May 2009: owing to the city's large number of passive house apartments, buildings and projects, Frankfurt assumed the title of 'Passive House Capital' on the occasion of the 13th Passive House Conference. Aside from three schools and several day-care centres, over 1,500 apartments covering a surface area of 300,000 square metres are currently built to passive house standards. The long list of planned developments comprises 50 projects, among them the first passive house hospital worldwide. The endeavours undertaken in this field have paid off: since 1990, energy management has resulted in profits in excess of 100 million.

Guidelines on cost-effective construction

Focussing on 'cost-effective' as opposed to 'cheap', the city of Frankfurt has drawn up guidelines on cost-effective construction in order to cut the total cost of public construction. The guidelines are based on the buildings' life cycle. The aim is to minimise capital, operating and environmental follow-up costs, all the way from the planning stage to demolition and disposal. All public construction projects and all contracts concluded with architects and engineers have been subject to the guidelines since 2005. The guidelines are available for download, also in English, at www.energiemanagement.stadt-frankfurt.de.

Definition of Passive houses



Passive houses? What are they?

On the outside, passive houses do not look any different than conventional buildings. 'Passive house' is not a brand name or building design. It is a quality standard combining high comfort with very low energy consumption.

What is the passive aspect?

Passive components, such as efficient heat insulation, highly efficient ventilation systems with heat recovery, insulated window frames with triple glazing, airtight building envelopes, optimum daylight alignment and the avoidance of thermal bridges, ensure that passive houses retain heat which consequently does not need to be supplied. In addition, passive heat sources, such as solar radiation, waste heat produced by electric appliances and humans as well as heat from exhaust air, cover a large proportion of the heat requirement. With the heat energy produced by children contributing substantially to the heating of rooms, schools or day-care centres are ideally suited to a passive house design.

What are the advantages compared to conventional buildings?

The overall concept results in a significant reduction in energy consumption compared to conventional buildings.

Comparison – passive house / conventional house:

On average, the mean specific heat consumption in schools and day-care centres in the city of Frankfurt/Main amounts to 142 kWh/m² per year. Normal use of passive houses results in a heating requirement of 15 kWh/m² (15 kWh are consistent with approx. 1.5 litres of oil or 1.5 m³ of natural gas). This represents an almost 90% saving compared to the average consumption. Passive houses also offer substantially greater comfort: drafts, cold corners or draughty window areas are a thing of the past and the ventilation system maintains high air quality standards at all times.

Passive houses are good-natured and forgive mistakes

Passive houses do not require different behaviour than normal buildings. With radiators not installed underneath the windows, if windows are accidentally left open, the houses do not necessarily lose heat. Due to the quality of the shell surface, temporary breakdowns of the heating system are hardly noticeable. Hence, a few details are different from conventional school buildings.

May the windows in a passive house be opened?

Yes, they may be opened but do not have to be. During the heating period, the ventilation system automatically maintains hygienic basic ventilation conditions without layers of cold air or drafts. If necessary, to guarantee good air quality, windows and doors should be opened for brief intense airing even during the heating period. In autumn, spring and summer, when heat recovery is undesirable, the ventilation system should be switched off and the house should be aired through open windows.

What is the difference between passive house windows and standard windows?

Windows in passive houses have triple glazing and are equipped with high-quality frame insulation. With windows looking south, they admit more solar energy into the building than heat is emitted to the outside. Thanks to the warmer surface temperatures ensured by triple glazing, radiators do not need to be installed directly under the windows.

Do passive houses get too hot in summer?

No, well-insulated building envelopes protect the houses not only in winter but also in summer. Heat does not penetrate the envelope. As a rule, rooms overheat due to solar irradiation through the windows. A comfortable room ambience also requires early use of solar protection. In longer heat periods, natural overnight ventilation is ensured via windows or night ventilation flaps. The ventilation system does not condition the air in summer since it neither cools nor dehumidifies the air.

Scheffelhof

Sustainable together

Ten townhouses were constructed in a community-oriented estate on a narrow plot of land east of St Bernhard's church. The semi-detached or terraced single-family homes are grouped around a joint access and recreational yard. The yard is a semi-public area where children can meet up and play. Each house has also been allotted a small private outdoor space. The buildings have 2 ½ floors with a recessed attic.The recess has been transformed into roof terraces which give access to roof gardens via external stairs. The individual buildings have been staggered to achieve the best possible light conditions. The windows and the recessed ceiling in the open balcony area let in a lot of daylight and provide the rooms with transparency. The planned joint sun protection system, which takes the form of a window awning, can be installed individually as required.

Passive house concept

All buildings were designed as passive houses. The central heating and ventilation element consists of a compact ventilation system with over 85 per cent heat recovery. The system is connected to a 300 l warm water storage tank that also serves as thermal buffer. The residual energy is generated directly from electricity. The hot water can be stored via a solar power system on the roof. The ventilation system guarantees a steady temperature of 20°C in all living areas. Additional heaters in the bathrooms can supply higher temperatures. The windows stretching over two floors, and the air space behind them, guarantee a large degree of daylight and substantial solar gains throughout the heating period.

Location
Scheffelstrasse, Frankfurt-Nordend
Completion
2008
Area
Gross cubic space 8,821 m³
Gross floor space 1,932 m²
including underground garage
Living area 1,462 m²,
between 125 m2 and 175 m² per unit
Ventilation concept
Compact ventilation system with over 85% heat recovery
Warm water storage tank with thermal buffer
Renewable energy
Solar thermal system
Contractor
Bauherrengemeinschaft Scheffelhof
Architects
Rook Architekten,
Stefanie and Hans-Dieter Rook
Costs
(KG 300 + KG 400) EUR 1,555/m²

Further information
www.greenbuilding-award.de and "Passivhäuser in Frankfurt – Bauen für die Zukunft", page 42

Tevesstrasse 36 – 54

Refurbishment with passive house components

This energy-efficient refurbishment of an existing building on Tevesstrasse was carried out at acceptable costs. The project involved passive house components associated with the construction of new passive houses which included top-quality heat protection on the building envelope and controlled apartment ventilation. The heating energy requirement was reduced to 1.7 l of heating oil equivalent per square metre and year. Due to the scale of the Tevesstrasse refurbishment, tenants were temporarily moved to other accommodation. The tenants were informed of the intended refurbishment measures one year in advance. The planners and tradesmen were also brought on board at an early stage. As a result, the ambitious cost target of just under EUR 1,000/m² of living space including VAT (DIN 276 KG 300/400) was achieved.

Passive house concept

Each apartment is equipped with its own ventilation system including heat recovery. The supply air pipes serving the living areas are laid in suspended ceilings in the hallway and the exhaust air pipes are laid invisibly above the door frames. This solution also enhances the sound insulation within the apartments. Special low-cost solutions were implemented in order to stay within the ambitious budget. In summer, the cellar rooms are dehumidified via simple mechanical ventilation systems based on bathroom ventilators. Additional holes were drilled into the exterior cellar walls to guarantee the air supply. With the help of the manufacturer of the thermal insulation composite system, the 30 cm thick insulation layer was stuck to the exterior wall without additional dowelled joints. Solar collectors with a total absorber surface of just under 65 m² were installed to support the water heating system. Some of the collectors are frame-mounted on a flat roof while others are installed on several sloped roofs above the stairways.

Location
Tevesstrasse 36–54,
Frankfurt-Gallusviertel
Completion
2006
Area
Gross floor space 1,340 m²
Ventilation concept
Compact units, heat recovery in each apartment
Renewable energy
Rainwater used for garden irrigation
Contractor
ABG Frankfurt Holding
Architects
faktor10, Gesellschaft für Siedlungs- und Hochbauplanung mbH, Petra Grenz, Folkmer Rasch

Further information
www.greenbuilding-award.de and "Passivhäuser in Frankfurt – Bauen für die Zukunft", page 44

Caritas-Quartier

Cross-generational residential and work ensemble

The Caritas-Quartier consists of a ‘House of Life’ that combines housing for different generations with care facilities, a children’s day care centre and the Caritas administrative office which also provides advisory services. The House of Life offers care facilities for 36 patients as well as 25 residential units of different sizes for singles, families and people with disabilities. It also features common spaces, such as a cafeteria, conference rooms, a roof terrace, a chapel and three shops. 140 office spaces and various meeting rooms are available in the advisory and administrative building. The conference area on the ground floor can hold up to 130 people. Four groups totalling 62 children aged one year and up attend the St. Leonhard day care centre. The centre point of the Caritas ensemble consists of a protected Renaissance stair tower that has been carefully renovated and integrated into the new building.

Passive house concept

The advisory and administrative building and the day care centre were built to passive house standard. Ventilation and heating is provided by a ventilation system. A geothermal field in the yard is responsible for heat generation in winter and cooling in summer. Toilets are flushed with rainwater collected in an underground tank. The St Leonhard House of Life complies with EnEV (German Energy Savings Act) standards. It is heated via a gas-fired condensing boiler with a heat and power unit.

Location
Leonhardskirchhof between Buchgasse, Alte Mainzer Gasse and Karmelitergasse in Frankfurt’s historic centre
Completion
2012
Area
Total property 3,900 m2 (net floor spaces: House of Life 7,300 m2, day care centre 600 m2, administrative building 4,400 m2)
Ventilation concept
Ventilation system for advisory and administrative building
Architect
GHP–Architekten, Oberursel
Project architect
Andreas Schling
Primary energy requirement
< 120 kWh²/a
Heating requirement
< 15 kWh m²/a
Heat generation
Geothermal energy

Further information
www.caritas-frankfurt.de/48706.html
”Passivhäuser in Frankfurt – Bauen für die Zukunft“, page 62

Location
Eschersheimer Landstrasse, Frankfurt-Westend
Completion
2011
Area
11,300 m² (108 residential units: rooms + apartments), 1,180 m² (day care centre)
Ventilation concept
Each apartment is equipped with a highly efficient individual ventilation device combined in joint equipment rooms
Renewable energy
Geothermal and solar thermal energy
Degree of coverage: 20%
Architects
Landes & Partner, Frankfurt, (houses A, D1, D2), Braun & Volleth Architekten (houses B, C and underground garage)
Heat generation
Heat pump system, deep geothermal energy, redundancy/residual heat via condensing boilers
Special feature
Heated rental apartment model, cross-generational residential concept (services on demand, day care centre)
Construction
Reconstruction of historic facade, compact construction style including thermal insulation composite system
Heating requirement
kWh 15/m²a
Blower door
h-1 < 0.4

Further information
www.abg-fh.de and ”Passivhäuser in Frankfurt – Bauen für die Zukunft“, page 54

Diakonissenareal in the Holzhausen district

Cross-generational residential ensemble

A cross-generational residential ensemble with 41 rental apartments, 51 senior citizen apartments, a children’s day care centre and an underground garage with 104 parking spaces was built on the former Diakonissenareal in the Holzhausen district of Frankfurt. A further 16 owner-occupied apartments will be realised in the context of a building contractor project. The overall project includes the construction of building components on behalf of the Diakonisse as well as demolition work and the construction of new buildings. ABG Frankfurt Holding is implementing a cross-generational residential concept, comprising rental and owner-occupied apartments for both young and old. 51 of the apartments will have access to services on demand, a model realised for the first time by Frankfurter Aufbau AG in the context of the Diakonissenareal. This includes an emergency call system in each apartment as well as optional services, among them care services.

Passive house concept

Geothermal energy will cover some of the heat requirement for all apartments offered as part of the heated rental apartment model. All apartments have an in-built floor heating system that also serves to cool the rooms in summer. In stand-by mode, the lifts require less electricity. Ventilation devices with heat recovery are installed in all apartments. They are located both in cellars and on roofs. The ventilation supply is located on top of the interior doors, while distribution pipes are laid in suspended ceilings. The facade of the former Diakonissen mother house was recreated in sandstone to ensure that the new building ensemble fits harmoniously into the cityscape.

Eulenberg day-care centre

The Eulenberg day-care centre is located in the recently constructed 'New Atterberry' residential area in the north of Frankfurt. The centre, which looks after six groups of children, was built to passive house standards on a relatively narrow piece of land. A vestibule leads to the small two-story foyer. The upper floor can be reached via a flight of stairs. Skylights provide natural light for the areas in front of the home rooms. Closed facade components dominate the specific character of the building and hint at its content. The silhouette motif of children holding hands creates an abstract ornament that is transferred to a plaster structure and overlaid over the facade. Cut-outs in the ornament provide openings in the structure which, in turn, determine the shape of the windows.

Passive house concept

Heat is generated via a gas-fired condensing boiler that supplies both the heating and hot water. The air intake and exhaust system involving 77 per cent heat recovery operates only during the heating period. Otherwise, the building is ventilated via the windows. Protection against summer heat is installed on the outside of the building. Two-piece tiltable and ventilated Venetian blinds and sufficient thermal masses are utilised to avoid overheating in summer. Natural overnight ventilation is ensured via automated night ventilation flaps. The window surfaces are optimised and have an over-temperature frequency of 3 per cent according to PHPP.

Location
Valentin Senger Strasse 61,
Frankfurt-Bornheim
Completion
2011
Contractor
Municipal education authority
Architects
dirschl.federle_architekten BDA
Heat generator
Gas-fired condensing boiler
Ventilation concept
Air intake and exhaust system with 77% heat recovery
Heat protection in summer
Outside: Venetian blinds, natural overnight ventilation via automated ventilation flaps, over-temperature frequency according to PhPP: 3%
Heating requirement
Calculated: kWh 15/m²a
Primary energy requirement
Calculated: kWh 120/m²a

Further Information
"Passivhäuser in Frankfurt – Bauen für die Zukunft", page 36

Location
Kalbacher Hauptstrasse 54,
Frankfurt-Kalbach
Completion
2011
Contractor
Municipal education authoritya
Architects
ARGE Architekten Marcus Schmitt, Frankfurt and Dietrich Untertrifaller, Bregenz
Heat generator
Gas-fired condensing boiler
Ventilation concept
Air intake and exhaust system with 80% heat recovery, 20m³/h outside air per person
Heat protection in summer
External venetian blinds, natural overnight ventilation via automated ventilation flaps, optimised window surfaces, over-temperature frequency according to PHPP: 0%
Energy reference surface
2,071 m²
Heating requirement
Calculated: kWh 15/m²a
Primary energy requirement
Calculated: kWh 100/m²a
Renewable energy sources
Roof surface suitable for solar or photovoltaic system, subsequent installation planned

Further Information
"Passivhäuser in Frankfurt – Bauen für die Zukunft", page 34

Kalbach primary school

The primary school in Kalbach received an extension building at its present site. The new building complements the old 1913 building and gym to form an overall ensemble. Shaped like an S, the new building forms various courtyards which are connected via the central hall.

The old building, which is situated 1.20 m higher than the new construction, is reached from the foyer via an external stairway. The multi-purpose room situated on top of the foyer creates a protected, covered entry loggia. A further focal point consists of the central hall which is also suitable for hosting events. All rooms are aligned according to daylight criteria. The secondary rooms have narrow strip windows according to the passive house concept, while the class rooms are equipped with generously sized windows.

Passive house concept

Heat is generated via a gas-fired condensing boiler that supplies both the heating and hot water. The ventilation system operates only during the heating period. Otherwise, the building is ventilated via the windows. The roof surface is suitable for installing a solar or photovoltaic system, both in terms of statics and structure. A respective subsequent installation is planned. Two-piece tiltable, reflective and ventilated Venetian blinds provide heat protection in summer while sufficient thermal masses prevent overheating. Natural overnight ventilation is ensured via automated night ventilation flaps (open at interior temperatures > 22°C and exterior temperature < interior temperature -2 K). The window surfaces are optimised and have an over-temperature frequency of 0 per cent according to PHPP.

Nordend integrated comprehensive school

The new cafeteria building is situated underground, arranged around a square daylight atrium, in order to maintain the vista of the ensemble. The underground location also preserves the full size of the school yard. A generous external stairway and the atrium lead to the cafeteria. Seats and seating steps invite students to sit down and eat in the open air. A lift close to the external stairway provides barrier-free access. The underground cafeteria opened in autumn 2011 after a one-year construction period. According to municipal stipulations, the construction complies with passive house standards.

Passive house concept

The new building is connected to the heating system in the old building which covers 100 per cent of the heating requirement and 85 per cent of the hot water requirement. In the kitchen area, the refectory and the interior rooms, an air intake and exhaust system with 75.5 per cent heat recovery provides 18 m³/h fresh air per person. Two-piece tiltable, reflective Venetian blinds ensure heat protection in summer while sufficient thermal masses prevent overheating. The window surfaces are optimised and have an over-temperature frequency of one per cent according to PHPP.

Location
Hartmann-Ibach-Strasse 54–58, Frankfurt-Nordend
Completion
2011
Contractor
Municipal education authority
Architects
schneider + schumacher Architekturgesellschaft, Frankfurt
Heat generator
Heating system in the old building
Ventilation concept
Air intake and exhaust system with 75.5% heat recovery, 18m³/h outside air per person
Heat protection in summer
Interior sun protection: Venetian blinds
Energy reference surface
386.4 m²
Heating requirement
Calculated: kWh 15/m²a
Primary energy requirement:
Calculated: kWh 237/m²a

Further information
”Passivhäuser in Frankfurt – Bauen für die Zukunft“, page 32

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Visit the passive house apartment exhibition by ABG Frankfurt Holding at ABGnova’s ‘SophienHof’ passive house, Ginnheimer Strasse 48.
Appointments can be made by phone or by e-mail at info@abgnova.de.

Imprint

Publisher
City of Frankfurt/Main, Energiereferat (energy agency)

Compilation
Stefanie Schütz, Energiereferat (energy agency)

Concept, Layout and Type
Marsel Djendjo Visuelle Kommunikation
www.md-viko.de

Printed Copies
1000

Printer
Henrich Druck + Medien, Frankfurt/Main
www.henrich.de
Papier: 170 g/m², holzfrei, matt gestrichen, Bilderdruck, LUMISILK, FSC®-zertifiziertes Papier

100% Aus vorbildlich bewirtschafteten Wäldern FSC® C016059

ClimatePartner° klimaneutral
Druck | ID: 10047-1303-1001

Mailing Adress
Stadt Frankfurt/Main, Energiereferat
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Information on Internet
This leaflet and further informations are available for download at www.energiereferat.stadt-frankfurt.de and www.energiemanagement.stadt-frankfurt.de