Wagner passive office building

EnBau

This was a pioneering project: in 1998, Wagner & Co Solartechnik's administration building was the first office building built according to the passive-house philosophy. This approach, which was ground-breaking at the time, was only decided upon during the planning phase, after the basis for the decision had been backed up by comprehensive thermal simulations. Despite the mixed reaction from architects, the building has proved to be a forerunner for a new generation of office buildings. The fresh air in this thermally well-insulated building is supplied by a ventilation system with heat recovery and an upstream ground-coupled heat exchanger. The remaining heating requirement is provided by a combined heat and power plant and a thermal solar system. The large solar system with a seasonal storage tank came from the client's own product range. An air-conditioning system was not deemed necessary, and humidification of the supply air is not needed in winter. This means that the building can be run with significantly lower air flows.

The first office building built in Europe according to the passive-house philosophy was also one of the first EnBau model projects – the administration building of a medium-sized solar technology company in Cölbe.

Building summary

Project status	Optimized
Location	Zimmermannstraße 12, 35091 Cölbe, Hessen
Completion	1998
Inauguration	1998
Building owner	Wagner & Co. (+ Betreiber, Nutzer)
Gross floor area	2,180 m^2
Heated net floor area	1,948 m^2
Gross volume	8,533 m^3
Work places	40
A/V ratio	0.36 m^2/m^3
Key aspects	Heat insulation, Daylight planning, Optimised lighting, Ventilation + heat recovery, Regenerative + passive cooling, Combined heat and power generation, combined heating and cooling, Heat / cold storage, Solar thermal energy, Optimisation of operations

Project description

Wagner's administration building is located in a business park in the small town of Cölbe, north of Marburg. The neighbouring buildings also belong to the company, and the office block is surrounded by one- to three-storey buildings. The building planning was the winner of a small selection process, where the use of a solar thermal system with a seasonal storage tank as a major component of the design was specified by the client... nomen est omen, after all.

Building concept

The building has a rectangular floor plan, with an additional round structure on the westerly side. The longer sides face south and north, respectively. Access between the storeys is located together with the secondary rooms on the north side of the building. The administration building houses a number of different functional areas. The ground floor is home to display rooms, a customer consultation area, a workshop and the dispatch area. The next floor has around 40 workplaces in open-plan and single offices. There is a dining area with a kitchen and a seminar area in the top floor.

The solar storage tank is an important component in the building services equipment and, at the same time, an important aesthetic element; it is located in the middle of the round structure. The building has gable and monopitch roofs which let in a lot of natural light.

This building was the first administration block to fulfil the high thermal requirements placed on passive houses. The standard of insulation is very high and the building envelope is designed to be airtight in order to eliminate

the possibility of uncontrolled ventilation losses. The energy harvested during the warmest six months of the year is stored using a seasonal storage tank, and can then be used during the colder period of the year. By using a solar system with a seasonal storage tank, the client is deliberately showcasing its own technology.
With U values of around 0.15 W/m²K, the building's insulation is at the level required for passive houses. A skeleton construction of reinforced concrete and a solid foundation slab are completely surrounded by an insulating envelope. In the facade and roof areas, this envelope consists of lightweight elements assembled using the wooden panel construction method, which have insulation thicknesses of up to 40 cm and are installed entirely outside of the supporting constructions. The foam-glass insulation under the foundation slab meets with the facade insulation at the bases of the walls. The windows employ thermally insulating triple glazing filled with inert gas, and are thermally separated from the wooden frames by a polyurethane core in order to minimise losses to the frames and glass composite.
Radiators are not used in supplying the small amount of heat required; heat is only distributed throughout the building by the ventilation system. This system, together with heat recovery, provides the basis for the low heating requirement of the building. The air-change rate is limited to the minimum of 0.3 to 1.0 air changes per hour that is necessary for hygiene purposes. The building is split into nine regulation zones. The rooms are supplied with air individually (air intake zones); they are then ventilated through the traffic areas to secondary rooms such as technical or sanitary zones (air extraction zones).

In winter

The earth tubes and heat recovery heat the outdoor air taken in. A preheating heat exchanger then heats the air to 25 °C. Small backup heat exchangers are present in the supply air ducts in the nine zones in the building in order to regulate the temperature on a zonal basis. The air can be heated to temperatures between 30 and 40 °C in this way. The preheating and backup heat exchangers are fed from the seasonal heat storage tank.
A four-way cross-flow heat exchanger removes about 80% of the heat from the outgoing exhaust air and transfers this heat directly to the supply air. According to plans, the building only has to be heated from December to February.

In summer

The building is cooled at night using natural ventilation. If necessary, the ventilation flaps in the roof area and the skylights in the offices are opened automatically. Thermal buoyancy allows fresh outdoor air to pass through the open-plan offices, through the entrance lobby and out again. This cools the uncladded floor slabs, which then act the following day as a thermal buffer for the room temperature. Heat recovery is bypassed in summer. An active cooling unit was added later to the area where computer servers are located. The installation area was initially conceived as an extraction zone, but the air entering here in summer proved to be too warm.

Building and technology concepts

Lots of daylight and externally mounted, electrically driven sun blinds on the east, south and west facades reduce the solar heat load. The blinds are split into two separate zones for control purposes, meaning that daylight can still be used even when the blinds are closed in the lower zone. Users are free to influence the automatic control of the blinds at any time. A strip of windows that is flush with the ceiling, located above the observation windows in the perforated facade, improves the daylight situation in the offices, which are up to 6 metres deep. The walls between the offices and corridors are not fully opaque, meaning that a minimum level of daylight also reaches the traffic areas. The ceiling lighting in the offices is automatically controlled using a bus system to provide a light intensity of 500 lux at the workplace. The light sensors employed here are located on the ceilings, beside the lights. There are no presence detectors; the ceiling lighting in the corridors is switched on and off manually.

Energy concept

Transmission and ventilation heat losses are systematically reduced in order to achieve lower heating requirements. Thanks to these measures, half of the remaining annual heating requirement of around 11 kWh per m² of net floor area can be provided by active solar energy utilisation. The solar energy harvested during the warmest six months of the year is stored using a seasonal storage tank, and can then be used during the colder period of the year. Prefabricated solar roof collector elements, each with a size of 10 m², provide heat during the summer months via a plate heat exchanger to an 87-m³-capacity water storage tank situated in the middle of the building. Feed to and from this tank takes place in a layered manner.
The remainder of the heating requirement is coupled with the generation of the electrical energy needed in the office building. A gas-operated combined heat and power plant (CHP plant) provides a portion of the electricity requirement and supplies heat energy to the heat exchangers. To extend the running time of the CHP plant to around 4,500 hours per annum, a large tank is used for buffer storage and an older neighbouring building was thermally coupled (to create a local heating system).

The reduced consumption achieved by automatic lighting control and electricity-saving devices means that the CHP plant is able to supply a large portion of the electricity consumed. A data-bus system controls the overall building services system. Rainwater is collected in an underground 11-m³-capacity concrete tank and used in the toilets.

Performance

The employees like the new building. The improved comfort compared to the offices occupied previously, and the ventilation system in particular, are emphasised here. Even without humidification of the supply air, which is often dry in winter, the average humidity of the exhaust air in the first winter was always above 30 %.

The measured values, which showed a maximum peak temperature of 29 °C in the offices at an outdoor temperature of 32 °C, confirm the effectiveness of the passive cooling concept consisting of effective shading, night ventilation and earth tubes.

The building has been in use since the end of 1998. The experiences so far have been very positive. Employees praise the good air (ventilation system), the bright rooms (use of daylight) and the pleasantly cool temperatures in summer. The company is pleased that there is public interest in the building, as this can only increase confidence in solar energy use. Evaluation of the measured data shows that the planned values have been achieved.

Optimisation measures and possibilities

During the course of the project, a number of optimisation measures were implemented. For example, it became clear during commissioning of the building that the setting of the freely programmable DDC system would take some time. Standard programs from manufacturers could only be used to a limited extent for this novel building project. Changes in the control of the performance of the heat exchangers were necessary. The settings for the lighting control system also required a lot of care. The target value for each sensor was set individually, depending on its position and the room situation.

Construction costs and economic viability

Despite the high energy standards and the additional components, the specific costs were below the typical value of 1,400 euros/m² p.a. according to the building costs index valid at the time for an office building with middle-ranging equipment and layout.

Key energy data

Energy indices according to German regulation EnEV (in kWh/m²a)	
Heating energy demand	13.50
Overall primary energy requirement	33.17
Measured energy consumption data (in kWh/m²a)	
Site energy for heating and domestic hot water (dhw)	23.10
Source energy for heating and domestic hot water (dhw)	16.20
Total source energy	65.80

Implementation costs

Costs of implementation in €/m²	
Construction (KG 300)	903
Technical system (KG 400)	228

These figures represent established costs

Net construction costs (according to German DIN 276) relating to gross floor area (BGF, according to German DIN 277)

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