

New climate in Karlsruhe printing company




It was a typical commercial property from the 1970s. The office building, which housed the pre-press for the ENGELHARDT + BAUER printing company in Karlsruhe with around 120 staff, had the same weaknesses as many buildings from this period: high energy consumption, inadequate daylight provision, poor air quality and thermally uncomfortable in summer and winter. The plan was to remedy these deficiencies as part of an extensive modernisation. The low-rise building had suspended ceilings which severely restricted the daylight utilisation. There was no ventilation system and the air quality was perceived as poor. The air renewal was particularly inadequate in summer, whilst in winter there were draughts.



The west facade of the printing building in Karlsruhe after being refurbished and extended.
© Patrick Beuchert, www.patrick-beuchert.de

Building summary

| | |
|------------------------------|---|
| Project status |  Optimized |
| Location | Käppelestraße 10, 76131 Karlsruhe, Baden-Württemberg |
| Year of construction | 1978 |
| Refurbished | 2006 |
| Building owner | E&B Engelhardt und Bauer (+ Betreiber und Nutzer) |
| Gross floor area | 1,389 m ² |
| Heated net floor area | 1,111 m ² |
| Gross volume | 5,153 m ³ |
| Work places | 50 |
| Key aspects | Facade systems, Glazing + windows, Daylight planning, Optimised lighting, Ventilation + heat recovery, Regenerative + passive cooling, Thermo-active building element systems |

Project description

The suspended ceilings reduced the ceiling heights and prevented daylight reaching the workplaces. Although equipment typical for printers and publishers, such as printers, plotters and high-performance copiers, were mostly housed in the work areas, there was no ventilation system. Particularly in summer, the air renewal in the open-plan offices was too inadequate to ensure a sufficiently good air quality. In winter the windows had to be frequently opened to ensure that there was a minimum air renewal. The suspended ceilings made it very difficult in summer for the building to absorb the peak thermal loads occurring during the course of the day within its building mass. This caused unbearably high room temperatures, which is why split air-conditioning devices for cooling purposes were later installed in individual areas of the building.

A refurbishment concept was developed for the building in 2004 and, in the following year, a general contractor was commissioned and the refurbishment work could begin. The building refurbishment and extension were largely completed by the end of the year, enabling the premises to be reoccupied at the beginning of 2006.

Refurbishment concept

The plan was to considerably reduce the energy consumption and to enhance the quality of the workplace by means of an innovative cooling system and a sophisticated building concept. This meant that the building had to be gutted and the facade demolished. The building was generously opened up to the outside, the suspended ceilings were removed and facades installed to the same standard as passive houses. Despite their lightweight steel construction, the heat-storing PCM ceiling panels which have been installed in the ceilings are designed to ensure a stable interior climate.

Based on preliminary tests according to VDI 3922, a concept for refurbishing the low-rise building was developed with the aim of combining workplace quality with energy saving. The low-rise building was gutted and the facades demolished. The shell was extended with a steel joist structure to create a second floor. The design of the facade was based on the construction principles used in passive houses. The winter case was assessed with the 2003 project planning package for passive houses and the summer case was assessed with a program for roughly assessing measures for passive cooling.

The average U-value of the building envelope is 0.54 W/m²K. Taking into account thermal bridging losses, this is derived from the U-values for the external wall (0.3), the floor plate (0.27), the roof (0.2) and the windows (1.4).

Energy concept

The following measures were planned to reduce the heating requirement and the electricity consumption while at the same time enhancing the quality of the workplace:

Optimised daylight utilisation and dispensing with automatic cooling reduce the electricity consumption.

Hybrid ventilation concept: Basic ventilation will be provided primarily in winter and can be supplemented with individual window ventilation. Heat recovery ensures that the supply air temperatures are also above 16 °C in winter. Warmth will be provided by means of underfloor heating.

Structural measures and ventilation with heat recovery lower the specific heating requirements from 160 to 21 kWh/m² p.a. Because waste heat from the printing machines in the printing hall is used, the natural gas boiler used for heating the low-rise building is no longer required.

Combined with some innovative structural measures, passive and renewable cooling shall also ensure a pleasant interior climate in summer, whereby the previous split air-conditioning devices can be dispensed with.

The external sun protection and the fundamentally improved daylight utilisation reduce thermal loads.

Natural overnight ventilation utilises the natural heat sink provided by night air and is solely achieved using the thermal lift within the building.

The ceilings are exposed and furnished with PCM ceiling cooling panels, which provide integrated latent heat storage (SmartBoard from BASF).

The building uses renewable cooling via borehole heat exchangers. The borehole heat exchangers are operated without heat exchangers; that increases the energy efficiency and reduces the system expenditure.

Water-filled capillary tube mats plastered in the ceilings actively extract heat and remove it to the borehole heat exchangers.

For the first time special PCM ceiling cooling panels were used on the ceiling, which combine latent heat storage with active cooling using borehole heat exchangers and capillary tube mats ("Ilkatherm aktiv" from Ilkazell Isoliertechnik).

Performance

The targets set for improving comfort have been largely achieved. However, high room temperatures still occur to some extent in summer. This is because the hydraulics for the cooling distribution system have been incorrectly installed. High pressure losses and partly inadequate circulation in the radiant cooling panels reduce the effectiveness of the renewable cooling. Because the cooling performance fell short of the planning objectives and, in addition, a too large circulation pump is used, the system's COP – a measure of the energy efficiency – is hardly any better than could be achieved by a good system with compression refrigeration machine.

Owing to an incorrectly set control system, the underfloor heating in the new building was not supplied with waste heat from the production as intended. Once the setting was corrected, however, it became clear that the heating capacity of the underfloor heating was still insufficient. The planned 100 per cent supply with waste heat cannot be guaranteed without further adjustments.

Optimisation measures and possibilities

In spring 2008, it is planned to modify the hydraulics for the cooling system in order to improve the COP and attain the planned performance. Furthermore, it is currently being considered whether to retrofit a daylight-dependent artificial lighting control system. This could lower the electricity consumption for the lighting by about 50%.

It is planned to improve the performance of the underfloor heating based on production waste heat by increasing the supply temperature. The cooling of the printing machines can be accordingly adjusted without any great expenditure.

In the next development stage, it is planned to use the borehole heat exchangers in winter as heat sources for a heat pump in order to supply other existing buildings.

Construction costs and profitability

Information on this subject will become available as the project continues.

Key energy data

| Energy indices according to German regulation EnEV (in kWh/m ² a) | before refurbishment | after refurbishment |
|--|----------------------|---------------------|
| Heating energy demand | 160.00 | 21.00 |
| Overall primary energy | | |

| | | |
|--|----------------------|---------------------|
| requirement | 344.00 | 86.00 |
| Related to heated net floor area | | |
| Measured energy consumption data (in kWh/m ² a) | before refurbishment | after refurbishment |
| Total source energy | | 215.00 |
| Primary energy lighting | | 140.00 |
| Primary energy climate | | 134.00 |
| Primary energy ventilation | | 98.00 |

Implementation costs

| | | |
|--|-----|--|
| Implementation costs in €/m ² | | |
| Construction (KG 300) | 860 | |
| Technical system (KG 400) | 370 | |

These figures represent established costs

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

[🔗 Scientific data from long-run monitoring \(in German\)](#)

[🔗 Projektinfo by BINE Information Service](#)

This project is funded within the framework »Energy Optimized Building« (EnOB) by the German Federal Ministry of Economics and Technology, on the basis of a decision by the German Bundestag. Get further information at www.enob.info.