Volkswagenbibliothek in Berlin

EnBop

The Volkswagenbibliothek, which belongs to Technische Universität Berlin, commenced operation in October 2004 after a protracted and somewhat complicated planning process. The ambitious energy concept developed by the Steinbeis Transfer Centre in Stuttgart encompasses various innovative approaches. The building was evaluated in terms of the energy efficiency and level of comfort shortly after it commenced operation. As part of an energy-oriented optimisation of the operation, the primary energy consumption was lowered within one year by 19 per cent. At the same time, the user comfort has improved tangibly.

Are libraries still relevant in the 21st century? The Volkswagenbibliothek's 5-storey building in Berlin offers its own very particular response to this question – here the view from the southwest.

Building summary

Project status	Optimized
Location	Fasanenstraße 88, 10623 Berlin, Berlin
Year of construction	Oktober 2004
Refurbished	Ende 2006
Building owner	Senatsverwaltung für Stadtentwicklung, Berlin (Bauherrenvertreter für das Land Berlin)
Operator	Gebäude- und Dienstmanagement der TU-Berlin (Projektsteuerung)
Occupant	Technische Universität und Universität der Künste Berlin (Nutzer)
Gross floor area	33,287 m²
Heated net floor area	29,532 m²
Gross volume	135,000 m³
A/V ratio	0.18 m²/m³
Key aspects	Ventilation + heat recovery, Regenerative + passive cooling, Thermo-active building element systems, Heat pump, Heat / cold storage

Project description

The building has been evaluated by the Institute of Building Services and Energy Design (IGS) at the Technical University of Braunschweig since spring 2005. A particular focus has been on the performance of the ground absorber, which is important for controlling the temperature of the building by means of concrete core activation. It uses the ground beneath the building as seasonal thermal storage. As part of the evaluation, diverse construction faults were rectified and the system made fully functional. Optimisation measures have been gradually implemented since the beginning of 2007.

Building concept

The five-storey building with a rectangular form is located in Fasanenstrasse, on the corner of Hertzallee, in Berlin-Charlottenburg. The building, which is aligned on a north-south axis, is entered from the Fasanenstrasse via a generous foyer. In addition to the entrance area, the west side also houses a cafeteria, lecture theatre and seminar rooms on the ground floor. The reading spaces are housed in the four upper floors on the west side. A patio with the two staircases is located along the middle of the building. The open-shelf stacks are situated between the patio and the office tract on the eastern side. The basement, which has almost twice the floor area as an upper floor, houses book stacks, technical rooms and a workshop.
The building envelope was constructed in accordance with the German Energy Saving Ordinance (EnEV) from 2002.

Energy concept

A central role in supplying energy to the library is played by the 8,100-m² ground absorber, which utilises the ground beneath the building as thermal storage.

Combined with concrete core activation in the offices and the reading spaces, the ground absorber is used for heating and cooling. A heat pump removes energy from the ground in the winter, enabling the ground to be used as a cold source in summer for free cooling. If the free cooling via the ground absorber is not sufficient to cool the ceilings, coolness can be supplied to the concrete ceilings via a chiller with a recooling system on the roof. The chiller also supplies the air cooling unit in the server rooms and the cool exchanger deployed for the ventilation systems used for the special book depot stored in the basement. In winter, peak loads in the offices and the reading spaces are met by deploying fixed radiators using district heating.

The open-shelf stacks are located within the building interior away from the facades and thus have reduced heating and cooling loads. As with the stacks in the basement, these are not cooled and heated via the concrete ceilings. In winter, these areas are supplied with district heating via the fixed radiators.

The office spaces in the building are ventilated throughout the year by means of the windows. The reading room spaces, open-shelf stacks and book depot in the basement are supplied with fresh air via air supply and exhaust systems. Sorption technology is used for the air supply conditioning, whereby the air is cooled and humidified by means of drying and humidity processes that respectively use district heat and water. External solar shading reduces the solar gain and thus the energy requirements for cooling.

Building management

All central systems are controlled by means of the building control system (BCS). Using the BCS computer, the operator can define time profiles and change target values.

Both the air supply conditioning via the air conditioning systems and the supply line temperature control for the heating and cooling systems are regulated centrally in accordance with the exterior temperature. This means that in accordance with the exterior temperature, the concrete core activation is also supplied via a two-pipe system in changeover operation with heating or cooling energy. Depending on the room temperatures measured via individual reference sensors, the control valves for the individual distribution circuits are opened or closed.

The users themselves have no influence on the regulation. It is only possible to provide auxiliary heating in the offices using the individual thermostatic valves on the fixed radiators. The air quality and, to a limited extent, the room temperature can also be influenced by means of manual window ventilation. The solar shading is controlled for each facade and in accordance with the weather. In individually used areas such as the offices and the seminar rooms, users can manually override the solar shading.

The energy management in the building is carried out by the TU Berlin. The Institute of Building Services and Energy Design (IGS) is supporting the TU Berlin with detailed operational analyses and, derived from them, optimisation proposals. By means of Internet-based data transmission, the BCS data is used for operational monitoring and analysis. In addition, a measurement concept was developed and implemented for recording the consumption and load profiles for the main energy generators and load groups.

Evaluation: Building performance

Incorrectly installed technical systems, control errors and regulation strategies that were not accordingly adjusted to the use of the building led to considerable problems during the initial operation. In addition, problems were also caused by the fact that the designers, installers and operators lacked experience in using the innovative and relatively complex seasonal geothermal systems and the sorption technology in the ventilation systems.

For example, neither the ground-coupled heat pump nor the conditioning of the supply air functioned reliably. Because a large part of the building systems equipment did not function, the energy and water consumption was too high. Furthermore, there was an unsatisfactory level of comfort with room temperatures ranging between 25 and 27 °C – both in summer and winter(!). It was possible to rectify one problem relatively quickly and simply: The supply temperatures for the concrete core temperature control were lowered to a sensible level. Prior to this, thanks to a non-functioning heat pump and an error in the control system, local heat was fed into the concrete ceilings at far too high a temperature.

The excessive room temperatures in summer are caused by internal loads that, as a result of a change in use, are considerably higher than that originally envisaged during the planning. The building systems equipment was not designed to cope with such high loads. The lack of heat removed from the ground during the winter months and the excessive absorption of heat by the ground during the first summer caused the ground to heat up. For this reason, the ground was unable to provide sufficient cooling the following summer.

It was possible to identify the three ventilation systems with sorption technology as major consumers of energy and water. One of the three systems alone uses 14% of the overall electricity, 22% of the district heating and 18% of the total water required in the building.

Optimisation: Potential, implementation and instruments

The operating analysis includes long-term monitoring to record the electricity, district heating and water consumption as well as the user comfort in the different areas of the library.

As part of the energy-oriented optimisation of the operations, numerous faults were rectified and, by means of various measures, the building services equipment were made fully functional. The measures decisive for improving the energy efficiency and comfort are listed below:

The operating times of the ventilation systems were reduced.

The “free ventilation” operating mode is now used more frequently, i.e. the operation is now based on an extended range of external temperatures. In this operating mode, the supply air is not conditioned; instead the exterior air is used directly as supply air.

The library is now passively cooled in summer: In the early hours of the morning, cool exterior air is fed into the building via the smoke extraction system.

The internal loads caused by the lighting have been reduced.

By rectifying the hydraulic faults in the system and optimising the control of the concrete core activation, it is now possible to utilise the geothermal energy more efficiently.

Improved control-based coordination of the concrete core activation and the fixed heating enabled more geothermal heat to be used for the room heating, i.e. more heat is extracted from the ground.

The high internal loads and the lack of cooling capacity provided by the ground absorber made it necessary to retrofit chillers. Operating this additional refrigeration technology contradicts the aim, however, of reducing electrical energy loads.

Cost-effectiveness and durability

In 2005, the primary energy consumption amounted to 317 kWh/m² p.a. (the values have been assessed with regard to the primary energy and standardised relative to the net floor area). Once the system was brought into a functioning state, these values initially increased in the subsequent year to 347 kWh/m² p.a. The optimisation measures in spring 2007 then reduced the consumption to 285 kWh/m² p.a. In 2007, the characteristic values for the final energy consumption for electricity was approximately 91 kWh/m² p.a. and for heating 57 kWh/m² p.a.

The rectification of faults and optimisation of the operation also considerably improved the thermal comfort in the library. For example, the number of hours of overheating in the reading rooms was reduced in 2007 relative to 2006 by up to 10% to 2% of the total hours of use (total 3,796 h p.a.). In the offices, which are used for a total of 2,600 hours a year, it was possible to lower the number of hours of overheating in each room, which initially ranged between 5 and 25%, to between 0 and 12%.

Since the measures carried out predominantly relate to changes in the operation, or were measures conducted as part of the rectification of faults in fulfilling guarantees, the implementation of the measures did not lead to any additional investment costs. This therefore enabled the energy costs for electricity and heat to be reduced in 2007 by around 126,000 euros compared to the previous year. In addition, around 13,000 euros were saved in regard to the water usage (for the sorption technology).

However, it will not become clear whether the energy-oriented optimisation of the operation leads to sustained savings in the long term until the results become available for the next few years. Additional potential has been identified for the ventilation systems using sorption technology. Moreover, the temperatures in the ground under the ground absorber need to be lowered further so that free cooling becomes possible again, enabling conventionally generated refrigeration to be replaced by renewable refrigeration.

More information will be provided during the course of the project.

Key energy data

Measured energy consumption data (in kWh/m²a)	before	potential	after
Total source energy	347.00		285.00

before: before optimisation, potential: according to optimisation potential, after: after optimisation

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