Head office of Siedlungswerk

EnBop

The head office building for Siedlungswerk gGmbH, which is situated in the centre of Stuttgart, was evaluated with a view to optimising its operation. The aim was to lower the energy consumption and at the same time make it more comfortable to use. The optimisation focussed on the heating and ventilation systems.

The main offices of Siedlungswerk in Stuttgart. The building is built on a corner site which forms part of the inner-city block structure.

Building summary

Project status	Optimized
Location	Heusteigstraße 27, 70180 Stuttgart, Baden-Württemberg
Year of construction	1992
Refurbished	2003
Building owner	Siedlungswerk gemeinnützige Gesellschaft für Wohnungs- und Städtebau mbH (+ Betreiber und Nutzer)
Gross floor area	8,370 m^2
Heated net floor area	7,533 m^2
Gross volume	29,064 m^3
A/V ratio	0.24 m^2/m^3
Key aspects	Facade systems, Glazing + windows, Photovoltaics, Optimisation of operations

Project description

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The Siedlungswerk office complex in Stuttgart was constructed at the beginning of the 1990s as a conversion and extension to an existing building in the city centre. In 2004, an evaluation and operation optimisation was conducted by Ingenieurgesellschaft EGS-plan from Stuttgart in coordination with the Institute of Building Services and Energy Design (IGS) at the Technical University of Braunschweig.

Building concept

The building is situated in the centre of Stuttgart on a corner site forming part of the inner-city's urban block structure. Siedlungswerk, a housing construction and urban development company, is the owner, administrator, operator and user of the building.
The building is not uniformly structured with the facade extending outwards by various amounts. On the western side of the site, an existing building was refurbished with a new extension constructed on its eastern side. The building's basement consists of two levels which are only partly heated. These also contain the underground garage (approx. 650 m^2), which is ventilated with exhaust air. Above the basement are four full storeys, whereby the ground floor is recessed by approximately 1 m on the north facade and by about 0.5 m on the courtyard side. On top there is a recessed storey with roof terraces.
Whereas the basement levels were constructed with reinforced concrete, the ground and upper floors including the recessed storey were constructed using steel with concrete cores to provide stiffening. The building is designed to allow double or triple access via the staircases to the different office areas. It is mostly based on a 1.35 m grid with 3.65 m floor heights. The room depths vary between 5.6 and 6.0 m.
The building provides a net floor area (NFA) of 7,533 m^2 and space for around 135 workplaces. Various types of areas were investigated to provide reference areas for evaluating the energy efficiency.

The building envelope was constructed in accordance with the German Heat Insulation Ordinance from 1982. Three facade types were developed with different window sections.
The building is almost exclusively used for office work. Adjoining it is a small cafeteria with a kitchen, which for the time being is only used to a limited extent, however. A room on the ground floor is used as the computer centre.

Energy concept

The building is supplied with electricity and gas. Two gas boilers with nominal capacities of 530 and 465 kW generate heat for space and water heating. Electrical chillers with dry recooling systems cool the building.
The recooling is carried out separately for each chiller. Two large chillers, each with a capacity of 120 kWth, are situated on the roof with integrated air-cooled re-coolers. A small chiller with a capacity 30 kWth is situated in the plant room in the basement with its recooler on the roof.
The heat and cooling energy is distributed throughout the entire building via a two-pipe system that is alternatively operated as required using a manual change-over. The building circulation system is connected to the plant room in the basement via two heat exchangers, whereby one is connected to the cooling circuit and the chillers, and the other to the heating circuit and heating boilers. The water is heated centrally.
The office spaces are heated and cooled by means of ventilation devices integrated in the facade. The heating or cooling functions are alternatively available only when the two-pipe system is correspondingly changed over centrally. Based on a reference temperature which can be regulated centrally for each room, occupants can control the desired temperature in the rooms within a range of +/- 3K.
The ventilation devices are located in the facade parapets. The supply air is drawn in via the facade, cooled or heated, and then fed into the offices via an outlet at floor level. The exhaust air is drawn through the triple-glazed window casement and released outside via a heat exchanger in the ventilation device. The amount of external air that flows through the induction device in the parapet can be regulated manually by the occupants. Using the rapid temperature override system, the circulation air ventilator can be operated quickly at level 3 or slowly at level 1.
In response to the corner situation dictated by the site’s perimeter development, the building is constructed with two parallel zones on the eastern side and with three parallel zones, which include a central core of windowless rooms, on the western side. The office space almost exclusively consists of cellular offices with room for up to 4 people. The workspaces are arranged so that the view is parallel to the windows. Light-weight partitions separate the offices. The partitions to the corridor include integrated cupboards with a clerestory window above them.
The offices are artificially lit with pendant lights with a capacity of approx. 14 W/m² near the windows and the workplaces, and by means of downlights on the corridor-side of the offices. The lighting can be operated manually for each workspace with on/off switches by the office doors. There is no central switching mechanism for the lighting or any other kind of automatic control.
The external solar shading on the east, south and west facades tracks the altitude of the sun. Internal vertical louvres have been installed in some offices to provide protection from solar glare. The corridor areas are lit with daylight via clerestory windows located in the partitions between the offices and the corridors. In addition, downlights have also been installed with an area-specific electrical output of approx. 8 W/m².

Building management

Some of the central systems are equipped with a DDC control system that can be operated by a PC (not, however, the switching over between the heating and cooling systems!). With the exception of the weather-dependent control of the solar shading, all room functions are regulated via individual room controls. These cannot be centrally controlled.
The building’s energy management systems are controlled by the owner in collaboration with EGS-plan GmbH. Detailed operational monitoring has been introduced which encompasses the main energy generators and user groups. The operational monitoring is carried out online using remote data capturing.

Evaluation: Building performance

An annual primary energy requirement of 196 kWhpe/(m2NFA p.a.) was calculated for the building in accordance with DIN 18599. The largest share comprises the heating energy with 65 % or 127 kWhpe/(m²NFA p.a.). The calculation was based on the conceptual situation after optimising the operation with predominantly naturally ventilated offices.
The building was evaluated in 2003/4. It was then optimised in terms of energy use. The primary energy requirement in previous years had exceeded 450 kWhpe/(m²NFA p.a.). After energy-oriented optimisation of operations, the mean annual primary energy requirement (2004-2006) was 304 kWhpe/(m²NFA p.a.). The characteristic values for the annual final energy requirement were approximately 64 kWhe/(m²NFA p.a.) for electricity and 102 kWhe/(m²NFA p.a.) for heat.

Optimisation: Potential, implementation and instruments
The operational analysis included the establishment of long-term monitoring of the electricity consumption by the building services systems and monitoring the user comfort in the office spaces.
It was possible to implement numerous optimisation measures.
- Reducing the operation of the chillers
- Blocking heating and cooling functions in change-over operation
- Lowering the heating at night and at weekends
- Optimising the operating times for the ventilation systems and switching to window ventilation in most offices.
Furthermore, several defects were remedied and faulty parts replaced for the measurement and control technology.

Profitability and durability
Overall, it was possible to reduce the energy consumption of the building by more than 30 % while simultaneously improving the user comfort. On concluding the optimisation of operations, the operational monitoring was continued. It shows that after two years, savings in energy costs of around 50,000 euros per year can be continually reached in operation. Therefore, it takes about three years to recover the total investment costs for energy-oriented optimisation of operations.

Key energy data

Energy indices according to German regulation EnEV (in kWh/m²a)	before		after
Heating energy demand	127.00		
Total source energy according to DIN 18599	196.00		
Measured energy consumption data (in kWh/m²a)	before	potential	after
Total source energy	456.00		304.00

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

Operating costs

Operating costs in €/m²a	before optimisation	after optimisation
Total energy costs	23.00	11.00

Payback time for optimisation measures

Payback time in years	
Total payback time	3

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