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BINE Informationsdienst

Administrative buildings as energy-efficient complex

- Primary energy consumption for heating, ventilation, cooling and lighting: 95 kWh/m² p.a.
- Energy-efficient floor-standing lamp with control management replaces general lighting
- Architectural concept adapted to the old-town character

Fig. 1

A new administrative centre was created in the centre of Eberswalde. The building complex offers spaces and paths that entice people to linger.

During the reform of the Brandenburg districts in 1993, the German district of Barnim was reformed. This led to a consolidation of the administration, which previously had been spread out across several locations in the city, in a new and central administrative building. Following a three-year planning and construction phase, the building complex for the local authorities and federal state parliament was erected and officially opened in the historic city centre of Eberswalde in 2007. Named after the local Eberswalde artist Paul Wunderlich, it also houses one of the world's largest Wunderlich exhibitions. The building chiefly functions as the Barnim Service and Administration Centre.

From the very outset, energy-efficiency and sustainability were important criteria, integrated as early as in 2003 in the European-wide interdisciplinary tender. At the early design stage, the planning team cooperated with the builder on facility management issues in order to later operate the building economically in terms of costs and resources. Specialist planners necessary for the building's energy concept were brought in at an early stage and simulations were conducted that went beyond the usual planning expense. A flexible, energy-efficient and zone-regulated floor-standing lamp was also developed which guarantees the general lighting as well as the workplace lighting in the offices. An important planning objective was to take into account the energy standards of the Energy-Optimised Construction (EnOB) support initiative: limiting the annual primary energy requirement for heating, cooling, ventilation, lighting and auxiliary energy to a maximum of 100 kWh/m² p.a. Today, this objective is reached in operation. The optimisation process of the building operation has yet to be terminated, allowing for further future reductions in the primary energy consumption.

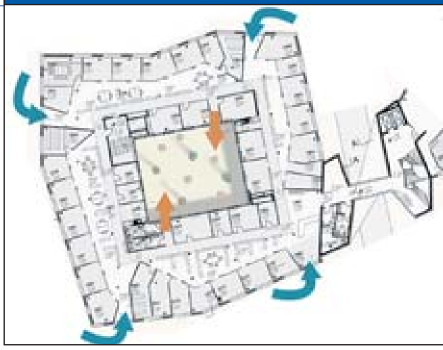
The scientific measurement programme as well as the increased planning expense and innovative technologies were sponsored by the German Federal Ministry of Economics and Technology. The energy consumption from heating, cooling, ventilation and lighting as well as numerous parameters were measured and then evaluated with the aim of controlling the technical operation in an optimal manner. First results of the monitoring process are now available, leading to individual building components being optimised.

▶ Building concept

The new building was constructed on what was previously fallow land in the old town of Eberswalde. The building complex comprises four compact buildings grouped around a shared interior courtyard. Each department has its own building – with its own facade design and infrastructure – which can be operated independently if necessary. Except for the district administrator's building which includes a plenum, all building structures have a central, glazed and unheated atrium. On the ground floor are commercial areas for businesses and gastronomy facilities. The upper floors are used by the administration. The workspaces of the 550 employees are organised in cubicle or combined offices as well as in group or open-plan offices. The 8-m² combined offices next to the outer facade are completed by a middle zone for joint use.

Fig. 2: Location in the old city centre of Eberswalde

Fig. 3: First floor Building D



A basic requirement for implementing a slim building and energy concept is thermal optimisation of the building envelope. The outer walls were prefabricated; they consist of a wooden panel construction, covered on both sides with planks and insulated with cellulose. The exterior has a ventilated facade construction with additional planking made of coloured fibre cement or plaster base panels. Thin vacuum insulation panels were installed between the external sun protection and the lintel. The wooden window frames are installed with thermally insulating triple glazing and a thermally insulating double glazing at the window vents. Foundation slabs, floor slabs and roofs as well as all the load-bearing supports and interior wall components are made of reinforced concrete.

Fig. 4: Building summary: Administration without atria and car park

Builder / investor	District of Barnim	
Planning and construction timeframe	2004 – 2007	
Structural design	Reinforced concrete and wooden panel construction	
Gross floor area (GFA)	21,631 m^2	
Net floor area (NFA)	17,131 m^2	4,878 m^{2}*
Main usable area (MUA)	11,755 m^2	3,600 m^{2}*
Gross volume (GV) as per DIN 277	69,109 m^3	20,127 m^{3}*
A/V ratio	0.3 m^{-1}	
Building air-tightness n_{50} value	0.8 h^{-1}	
U-value, windows	1.0 and 1.4 W/m^2K	
U-value, exterior walls	0.20 W/m^2K	
U-value, roof	0.12 W/m^2K	
U-value, floor against soil	0.17 W/m^2K	

*Building D

▶ Energy concept

Due to the difficult hydro-geological building ground conditions a basement was not possible. Instead, the conditions called for a pile foundation. Given the circumstances, installing energy piles to utilise the soil as a source of heat and cold was a viable option.

Heating, cooling and ventilation

Heat pumps provide the basic heat supply. 593 of the 850 foundation piles required for static loading were equipped with absorber registers which extract warmth from the ground to heat the building in winter and are used as a source of cold in the summer. The heat is distributed across radiators on the outer facade and via the ventilation system. The supply air is distributed to the office spaces via pipes in the ceilings. The exhaust air leaves the rooms by flowing directly to the combination zone, dissipating its heat to the supply air by means of a rotary heat exchanger. In addition, corridors and the combination zone are also heated by means of an underfloor heating system. For temperatures above 8 °C the heat pumps mainly use outside air as heat source, which is connected via the recooler (air-water heat exchanger).

Thermally activated concrete masses and additional phase change materials (PCM) – in combination with the ventilation system, the night ventilation via automatically opening windows and the exterior sun protection – ensure comfortable room temperatures. Heat is dissipated via the ventilation system and the underfloor cooling system. Connected via the energy piles, the ground serves as heat sink up to a return temperature of approx. 20 °C. If the return temperature is higher, the system switches to the water-glycol recooler on the roof. To cover peak loads, cold is generated actively via the reversible heat pumps (Fig. 5).

Daylight optimisation and artificial lighting concept

Besides improving the energy efficiency, an important criterion when planning the lighting was to increase occupant comfort. With this in mind, there are no visible lintels and the ratio between storey height and room

▶ Energy concept: system components

System	Components	Details
Heating/Cooling	< 8 °C: heat pumps with geothermal heat source via energy piles	593 foundation piles with absorption system, depth approx. 9 m; heat distribution via radiators, ventilation, underfloor heating Building D: heating capacity: 88.4 kW_{th}; cooling capacity: 100.3 kW
	buffer storage tanks	for heat and cold, 1,500 litres each in building D; similar in other building sections
	peak load cover, cold generation via reversible heat pumps	switching to water-glycol recooler on the roof, no full air conditioning
	building element activation	concrete masses of ceilings, PCM
Water heating	decentralised	by means of electricity, continuous flow heater
Ventilation	ventilation system	supply air via ceiling-integrated pipes, overflow into combination zone, deaeration via atria, heat recovery (rotary heat exchanger)
	automatic night ventilation through windows	
Lighting	natural lighting	direct lighting of offices, indirect lighting of combination zone
	sun protection and glare protection	two-section, exterior blinds, centrally controlled; interior glare protection, manually controllable
	artificial lighting	floor-standing lamps for room illumination; controlled by building control technology, dependent on daylight conditions and building control technology

Fig. 5: Integrated energy and building services equipment concept

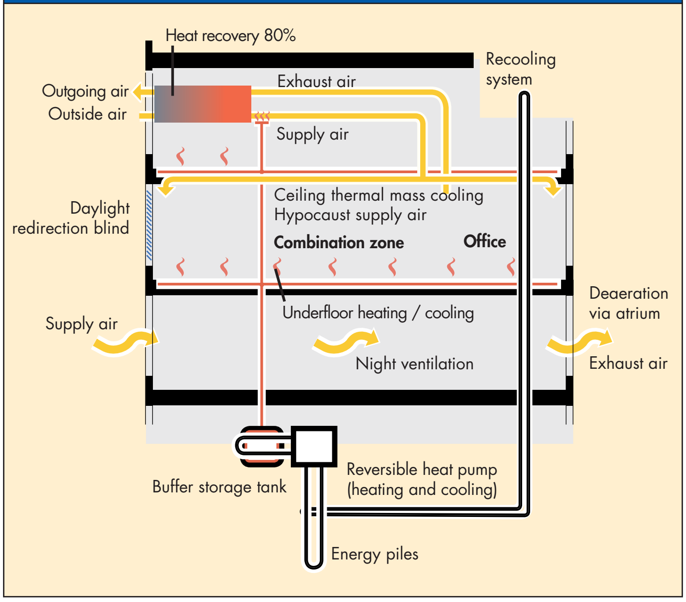


Fig. 6: Daylight and artificial lighting concept

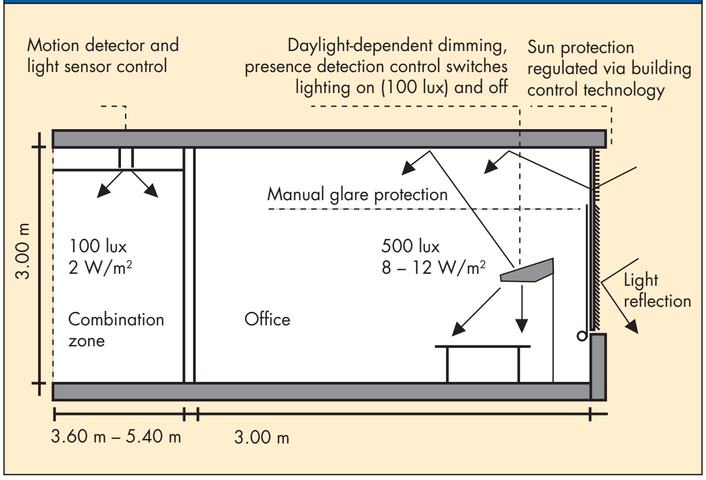


Fig. 7: Improved floor-standing lamp

depth has been optimised. The outside sunshade blinds are in two sections and when closed the light enters the room depth through the upper part. The building control technology regulates the sun protection automatically for each facade and storey according to the irradiation and temperature. The interior glare protection can be positioned individually (Fig. 6). In collaboration with a manufacturer, the planning team has improved an energetically highly-efficient floor-standing lamp with an increasing percentage of indirect light as the room depth increases, guaranteeing general lighting in rooms and workspaces. The floor-standing lamps are controlled by the building control technology by means of light level and presence detector. The light level can also be adjusted individually by the user. The combination zone is lit indirectly with daylight via glazed office doors and glass partition walls. Here, electrical lighting is controlled based on the daylight situation and presence detection.

▶ Monitoring

Building D, which in contrast to the other buildings is used exclusively for administrative purposes and is not available for any other use, was monitored intensively during the first two years of operation (Fig. 3). The effects of the initial optimisation measures are currently being evaluated and the energy and comfort measurements will be continued until 2010.

The 2008 consumption values show that the primary energy requirement was even lower than the target value of 100 kWh/m² p.a. The scientists conclude that the primary energy requirement can be further reduced provided that the building operation is optimised according to the monitoring results. In 2008, the supply temperatures for example were partly too high; both heat pumps were running in partial load operation simultaneously. Building control technology problems led to the new lamps remaining on at night and the automatic window night ventilation only being operational since June 2009. These operation optimisation issues have largely been dealt with.

The heating energy consumption is significantly higher than the planned value. The reason for this is very comfortable room temperatures of about 23 °C to 24 °C in winter. The planned value was 20 °C, which may have been a too low estimate for mainly seated work activities.

The monitoring also showed that the heat base load was not distributed via the ventilation system as planned but via the radiators, which were actually only intended to cover peak loads.

The heat pump's air operation has not been required so far, since the ground does not cool down enough for the air to be put to energetic and technical use. In addition, as part of the optimisation measures, the ventilation system will only operate at intervals in the winter so that the air does not dry out too much.

Thermal comfort

Thermal comfort measurements were carried out within the scope of the monitoring. The air speed, carbon dioxide levels in the indoor air, air humidity and temperature as well as the illumination level were measured at selected office workspaces. The supply air temperature and the air stratification in the room were also measured. The thermal comfort concluded from these measurements was practically always within the comfortable range.

Fig. 8: Energy parameters based on heated NFA

	Planning as per EnEV (implementation plans) [kWh/m² p.a.]	Operating year 2008 (measurement) [kWh/m² p.a.]
Lighting	37	33.5
Heating	18	25.5
Cooling	9	6.1
Auxiliary energy and pumps (heating, cooling, sanitary drives and fans)	29	29.9
Total primary energy as per DIN 18599, specification of support concept < 100 kWh/m² p.a.	93	95

Fig. 9: Gross construction costs according to DIN 276 based on net floor area. Reference value from building costs index (BKI)

Building costs (cost group 300)	EUR 849/m²
Technical equipment: cost group 400	EUR 413/m²
Total	EUR 1,263/m²
Reference value from BKI, medium standard	EUR 1,150 to 1,650/m²

▶ Conclusion

The concept for the Paul-Wunderlich-Haus worked very well. A lot of commitment from the outset from all parties involved, clearly defined goals in the tender and implementing these goals in the planning and construction stages have made possible an impressive building complex not only in terms of energy efficiency and user comfort, but also a building complex which is trend setting in terms of aesthetic appearance and urban development.

Particularly noteworthy is the fact that the target primary energy consumption could be reached even in the first operating year. The energy consumption values measured correspond roughly to the planned values although the room temperatures for instance were above the defined value of 20 °C in the winter. Monitoring the building enabled us to identify malfunctions in operation and to rectify most of them. Comfort measurements show that the thermal comfort is within a very good range. Monitoring will continue until 2010 and it is to be expected that the consumption values will be improved even further due to the running optimisation process.

Commissioning a building with demanding building control technology and integrating the measurement technology required for monitoring are very complex processes. This also proved to be the case in the Paul-Wunderlich-Haus. Individual building components such as the nightly automatic window transverse ventilation or controlling the outside blinds were problematic at first. Installation companies found it difficult to implement these components. Very careful planning and documentation of the commissioning while cooperating even closer with the building operator during this important project phase would have been very helpful.

In operation, technology does not govern the energy consumption alone. An informed user can contribute towards a comfortable and energy-efficient operation of a building. That is why a user manual explains the concepts and functionalities of the Paul-Wunderlich-Haus.

Since January 2009, the Paul-Wunderlich-Haus has been one of the first buildings to hold a golden German quality label for sustainable building. All aspects of sustainable building are taken into consideration: ecological factors and economic efficiency, as well as socio-cultural, functional and technical aspects, process quality and separately site-specific issues.

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▶ ADDITIONAL INFORMATION

Literature

- Löhnert, G.; Dalkowski, A.: Dienstleistungs- und Verwaltungszentrum Barnim. Schlussbericht Phase I. Landkreis Barnim (Ed.). 2008. FKZ 0335007V. Available on loan from TIB Hannover, Germany, Signature F 09 B 1387

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- www.enob.info
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- www.teamgmi.com

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- Fig. 1: Martin Duckek
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- Figs. 2, 3 and 5: GAP, Berlin
- Fig. 6: EnOB accompanying research
- Fig. 7: Dr. Günter Löhnert

Service
- This Projektinfo brochure is also available as an online document at www.bine.info under Publikationen/Projektinfos. Additional information in German, such as other project addresses and links, can be found under “Service”.

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