BINE Informationsdienst

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Energy-efficiency in newly built public buildings

- Energy consumption 50% better than German Energy Saving Ordinance (EnEV) standards
- Good thermal comfort and visually attractive
- Simple energy concept has proven successful
- Low construction and operating costs

Fig. 1

The well-defined facade of the 'Neues Regionshaus' building in Hanover

The Hanover region has built an office building for around 300 employees in the centre of Hanover, Germany, the federal state capital, to serve the citizens in the region from a single location. The new constructions have added a six-storey block with office space and a one-storey, protruding rectanguloid structure housing the 'Regionssaal' hall to the existing facilities. Alongside the provision of high-quality workplaces, the issue of operating costs has also become an important criterion in new public-sector administration buildings. The concept therefore included ambitious values for primary energy requirements combined with a strict financial framework. The 'Neues Regionshaus' in Hanover is intended to demonstrate that energy-optimised building can be used for public buildings in a competitive environment too.

The project is implemented as part of a "Public-Private Partnership" (PPP) and includes the entire planning work, construction, and financing of the building over 20 years. Since the new constructions in Hanover represent extensions to existing office buildings, the Hanover region decided against outsourcing operating services as part of a PPP. Thus, building maintenance and technical maintenance for the entire complex will remain 'under one roof'. An important priority for the Hanover region was to take into account the energy standards of the Energy-Optimised Construction (EnOB) support initiative: the primary energy requirement for heating, cooling, ventilation, lighting and auxiliary energy is limited to a maximum of 100 kWh_{PE}/m^2_{NFA} p.a. The scientific measurement project was supported by the German Federal Ministry of Economics and Technology (BMWi). The project was also sponsored by pro Klima.

After three years of preparation, planning and construction, the administration building went into service in April 2007. Scientific support as regards energy efficiency and user comfort was provided by the Institute for Building Services and Solar Technology at the Technical University of Braunschweig during the planning and construction stages and the first two years of operation. The energy consumption and numerous parameters relating to heating, cooling, ventilation, lighting and building equipment were measured using measuring points and then evaluated with the aim of controlling the technical operation in an optimal manner. The Institute for Psychology at the University of Magdeburg carried out a social-scientific study and surveyed users on their experience with the building. How is the new building being received by staff? How can building performance be further improved? The first results of the monitoring process are now available.

Building concept

The 'Neues Regionshaus' building is an addition to a complex of existing buildings in Hanover's city centre. The compact reinforced-concrete extension forms an additional inner courtyard together with the existing structures. The character of the surrounding buildings is defined by the 'Stadtbibliothek' – the City Library, which is housed in a listed Expressionist building – and other buildings dating from the 1950s. The materials and colour scheme blend in with those of the existing surroundings. The well-defined facade was built using bright limestone and dark anthracite-coloured granite, which makes the window openings in the facade appear larger. The 'Regionssaal' hall stands out prominently in front of the six-storey new building and extends almost as far as the public footpath. The result is a harmonious combination of the old and the new. The hall building, which can accommodate 540 people and be divided into three smaller halls if necessary, allows for maximum use of daylight, even when the hall is divided into smaller units.

For cost reasons, it was decided not to include basements or an underground car park. Parking spaces were provided at the rear of the site. Wood-aluminium windows with insulating glass units and 16-cm external wall insulation made of mineral wool ensure good thermal insulation of the air-tight facades.

Office concept

There are 191 office rooms, each intended for two employees, in the upper storeys. The 20-m² rooms are comfortably furnished and equipped for the users. For example, sun and glare protection is integrated into the cavity between the glass panes in the window units, with daylight redirection in the upper third. Daylight can enter even when the sun protection is closed. In the case of strong solar irradiation, the sun protection is automatically pulled down once per day during a time period that depends on the orientation of the facade. The sun protection can also be operated manually, in which case automatic control is switched off for the rest of the day. The lighting, which is controlled based on presence and brightness and has both direct and indirect elements, adds to the energy-efficient lighting concept. The ability to switch off the power supply to all the equipment sockets on each floor and concrete core activation for room cooling both lead to further comfort and energy savings. Because of the concrete core activation, sound-absorbing ceiling panels were installed to improve the room acoustics.

PPP financing model

Based on the experience of other regional bodies, the client, the Hanover region, considered whether to implement the project as part of a Public-Private Partnership, or PPP for short. This idea was investigated by means of a feasibility study which had the goal of identifying potential economic benefits. The results of this study were positive, and so the region decided to use the PPP financing model. The various services such as planning, construction, financing and, if necessary, operation can be acquired as a single package, which is in contrast to conventional acquisition methods for public clients. The private company can then operate independently and carries risks itself; when purchasing services, it does not have to act in accordance with the formalities and decision-making processes which apply to public bodies. The PPP tender defines all the important targets – such as energy efficiency and user comfort in the case of the 'Regionshaus' in Hanover. According to the criteria in the tender, the most cost-effective offer will be awarded the contract. The next step is to negotiate the details of the contract between the contractor and, in this case, the Hanover region. The contract is a combination of a construction contract and a financing contract. Once the building has been handed over in a ready-to-occupy state, the quarterly payments commence and continue over a period of 20 years, after which the building becomes the property of the client.

Fig. 2: Floor plan of the ground floor

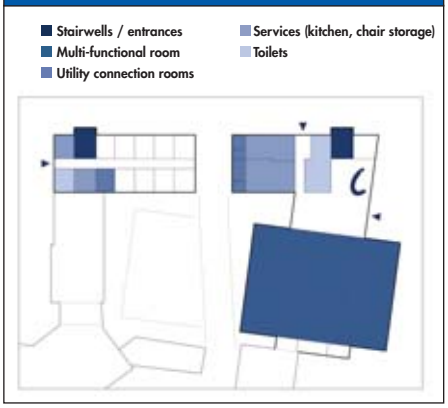


Fig. 3: View of the interior of an office room

Fig. 4: Building summary

Client/Investor	Hanover region/ Molana Vermietungsgesellschaft
Planning and construction timeframe	2004 – 2007
Structural design	Solid reinforced-concrete construction

Gross floor area (GFA)	8,441 m²
Net floor area (NFA), heated (area with energy requirement)	7,134 m²
Main usable area	3,599 m²
Gross volume as per DIN 277	28,911 m³
A/V ratio	0.3 m⁻¹
Air-tightness for entire building, measured in 2005	0.4 h⁻¹
U-value, windows	1.2 W/m²K
U-value, exterior walls	0.23 W/m²K
U-value, roof	0.18 W/m²K
U-value, floor	0.29 W/m²K

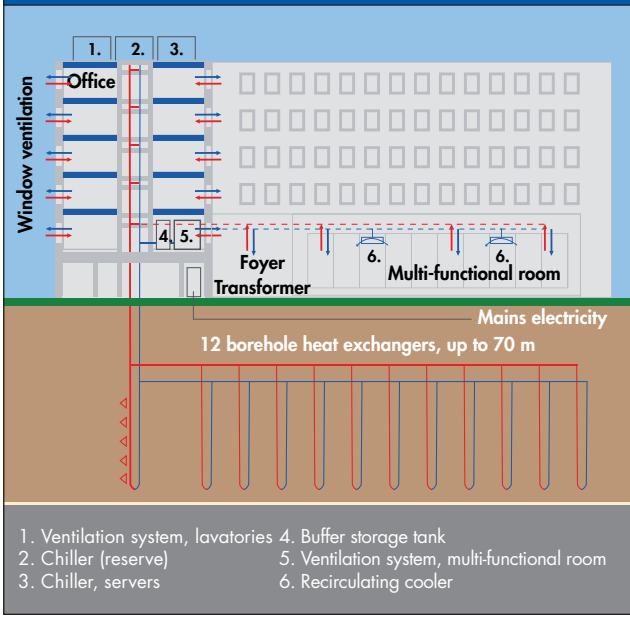
Heating, cooling and ventilation

The calculated heating requirement for this compact and well-insulated building is comparatively low at 34 kWh_E/m^2_{NFA} p.a. A simple, reliable and low-maintenance energy concept will ensure comfortable indoor temperatures. An air-tight building envelope and windows with integrated sun protection are further prerequisites for energy-efficient operation. District heating is used. The rooms have radiators with thermostat valves. Ventilation is solely by means of the windows. The 'Regionssaal' and the sanitary facilities are fitted with a ventilation system that employs efficient heat and moisture recovery. Concrete core activation is used for room cooling. Cold water is pumped through plastic pipes in the floor slabs in summer to remove heat from the rooms and keep the temperature at a pleasant level. The water heated in this way is then cooled again in borehole heat exchangers. A chiller is provided as a reserve. The borehole heat exchangers are used in winter to preheat the outdoor air for the ventilation system using a further heat exchanger (Fig. 5). The combined effect of these measures is that the building is around 50% below the legal requirements of EnEV. The building control technology and the comprehensive measurement equipment allow for fully remote monitoring of the building operation.

▶ Energy concept: System components

System	Components	Details
Heating/Cooling	Connection to district heating from a CHP plant	
	Borehole heat exchangers	12 exchangers; drilling depth: 70 m; cooling capacity: 48 kW
	Concrete core activation	Supply temperature, summer 16 °C
	Buffer storage tank (cold water)	1,000 l
Water heating	Decentralised, using electricity	
Ventilation	Window ventilation in offices	
	Hall and sanitary facilities, ventilation system	Hall: HR (rotary heat exchanger), preheating using borehole heat exchangers
		Sanitary facilities: cross-flow heat exchanger, preheating coupled with cooling of servers
Cooling, concrete core activation	Plastic pipes in ceilings	
Lighting	Natural lighting	
	Glare and sun protection in cavity between the glass panes	
	Artificial lighting	Direct and indirect mirror luminaires with presence detectors

Fig. 5: Energy concept in summer



▶ Operating results

Fig. 6: Energy parameters based on heated NFA

	Planning as per EnEV	Operating year 2008
	[kWh_{PE}/m^2_{NFA}p.a.]	[kWh_{PE}/m^2_{NFA}p.a.]
Primary heating, district heating	46	30.8
Primary energy for electricity, auxiliary energy, ventilation, lighting, pumps	47	51.3
Total primary energy as per DIN 18599, specification of support concept < 100 kWh/m² p.a.	93	82.1
Primary energy for equipment only: kitchen, hot water, PC equipment		39.1

Fig. 7: Gross construction costs as per DIN 276 based on NFA, comparison with reference value from building costs index (BKI) from the Baukosteninformationszentrum Deutscher Architektenkammern

Building construction (cost group 300)	EUR 762/m²
Technical systems: cost group 400	EUR 282/m²
Total	EUR 1,044/m²
Reference value from BKI, medium standard	EUR 1,150 to 1,650/m²

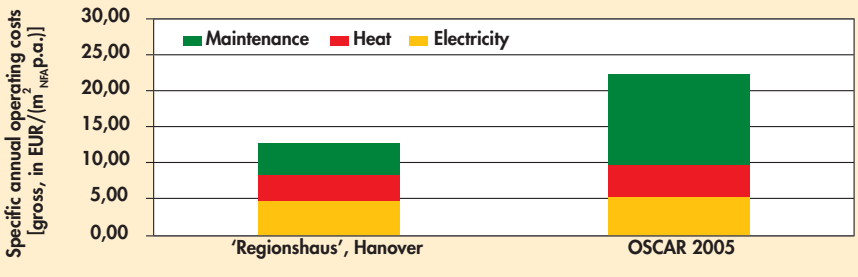
Intensive monitoring accompanied the project during the first two years of operation. Building performance and the optimisation of performance are measured as part of a measurement programme and also investigated in terms of environmental psychology. The results from 2008 confirmed the trends established in 2007: the primary energy requirement excluding electronic building equipment was 82 kWh/m^2_{NFA} p.a., which was below the planning values (Fig. 6). There has hardly been any need to use the array of borehole heat exchangers, as cooling of the office rooms has not been necessary. Only in winter has the supply air for the ventilation system for the 'Regionssaal' been preheated by the borehole heat exchangers via a further heat exchanger. Most users are very satisfied with the indoor temperature in the building over the course of the year, but some requested changes regarding the automatic control of the sun/glare protection in the first year of operation. In response to this, the automatic control was made more sophisticated. As soon as a user manually adjusts the sun protection, the automatic control is switched off for the rest of the day in question. Beforehand, this only happened for the next 2 h, after which the sun protection obeyed the default settings again.

Apart from this, only minor optimisation measures were necessary. For example, the control of the ventilation system for the hall was improved in the first year of operation. Defective electronic components initially led to dissatisfaction with the lighting in some offices. Otherwise, there were few teething problems, meaning that building operation was ideal almost right from the beginning.

Economic viability

Compared to other office buildings (as per the reference value in the BKI building costs index), the construction costs were low (Fig. 7). The operating costs including maintenance are also an important criterion for long-term operation. When compared to other administrative buildings, the 'Regionshaus' in Hanover shows that an energy-saving building with an efficient energy concept leads to significantly reduced operating costs (Fig. 8).

Fig. 8: Calculated operating costs for 2008 (electricity, heat, maintenance) compared to OSCAR 2005 (Office Service Charge Analysis Report)



Conclusion

The concept applied to the 'Regionshaus' in Hanover has proved itself in practice. The result is a cost-effective, energy-saving and sustainable building that has a simple, but effective energy concept. Success in Hanover has been a result of the precise definition of energy goals at the beginning of the construction project combined with quality assurance which accompanied the project from initial planning right through to operation. Implementation as a PPP made it necessary to define a clear and complete scope of services and explicit performance goals at the start of the project. The opportunities for making changes after the contract has been signed are very limited. The PPP concept worked very well in Hanover. When compared with the BKI reference value, the construction costs for the building were in the lower range of the medium standard. Building operation is both energy-efficient and economically viable – this will continue to be studied in more detail as part of EnOB accompanying research. At around 82 kWh_{PE}/m^2_{NFA} p.a., the consumption values for primary energy are actually below the planned values, and are almost 20% below the energy standard of the EnOB support programme. Building management is carried out by the Hanover region's employees.

It is noteworthy that it has not yet been necessary to cool the office rooms. This is due to the design's moderate proportion of windows in the facade of only 30%, and also to the effective sun protection. This closes when irradiation values are too high. A room which faces east is protected from overheating in the mornings, even when employees are not yet at work. The summers of 2007 and 2008 also played a part, as they did not feature longer periods of warm weather.

Users of the building are satisfied with their workplace. Since the end of 2007, a service portal has been available to them on the Intranet, where wishes and complaints can be sent to building management. The users can view the status of their current entries at any time. In the first one-and-a-half years, more than 600 items regarding the new building were worked on centrally. In addition, a user manual was created which explains in a clear manner the various options for controlling the building services equipment at the workplace and in the 'Regionssaal' hall.

Since January 2009, the 'Neues Regionshaus' in Hanover has been one of the first buildings to hold a golden German quality seal for sustainable building. The certificate for energy-efficient building is based on various aspects that are indicators of the sustainability of projects.

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ADDITIONAL INFORMATION

Internet
- www.enob.info
- www.hannover.de
- www.buenemann-collegen.de
- www.energydesign-bs.de
- www.igs.bau.tu-bs.de
- www.uni-magdeburg.de/wipsy/

Literature (in German)
- Film material on the building can be viewed at www.building-performance.net.

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- Fig. 1: Bilfinger + Berger, Mannheim, Germany
- Fig. 2, background image, page 1: IGS, Braunschweig, Germany
- Fig. 3, background image, page 4: bünemann + collegen, Hannover, Germany

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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