Science College in the Overbach education centre

EnBau

A model project for the research topic of “Energy-efficient schools”: in summer 2009 the existing Haus Overbach education centre gained two new buildings – a scientific education centre and a guest house. This new facility, the Science College, is intended for students and young adults in Germany and abroad. They come to attend courses in the natural sciences at this centre, in addition to their regular classes at home, in order to work intensively in a university-type environment. Both new buildings fulfil the requirements for passive houses. The Science College building features a high insulation standard in the building envelope, window systems with switchable glazing, and intensive use of daylight with roof heliostats. The heating and cooling requirements are satisfied by a heat pump system with borehole heat exchangers combined with a building element activation system. The building will be monitored scientifically until 2011.

The Science College shortly after the inauguration of the building on 27 June 2009.
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Building summary

Project status	In Operation
Location	Franz-von-Sales-Str. 16, 52428 Jülich-Barmen, Nordrhein-Westfalen
Completion	6/2009
Inauguration	6/2009
Building owner	Ordensgemeinschaft der Oblaten des hl. Franz von Sales (OSFS) e.V.
Gross floor area	2,182 m^2
Heated net floor area	1,730 m^2
Gross volume	10,274 m^3
Work places	320
A/V ratio	0.37 m^2/m^3
Key aspects	Glazing + windows, Daylight planning, Daylight systems, Optimised lighting, Ventilation + heat recovery, Regenerative + passive cooling, Thermo-active building element systems, Heat pump, Heat / cold storage, Control technology, operational management, building automation, Solar thermal energy

Project description

In Jülich (North Rhine-Westphalia), the order of the Oblates of St. Francis de Sales has for decades operated an educational centre with a state approved grammar school, a youth education centre specialising in music, and a boarding school. As a MINT-EC school, the school is a centre of excellence for mathematics and the natural sciences. This initiative is sponsored by the German Federal Employers’ Association and currently includes 100 schools in 15 states in Germany. For some time the order had been considering setting up a Science College with a guest house to enable them to offer intensive courses for visiting students.
Following several years in which plans failed to make much progress, in 2006, working in collaboration with a central project coordinator, the order succeeded in securing enough support for the idea from public funding bodies and industrial, NGO and private donors to enable the realisation of an ambitious building. With its upscale architecture and energy-efficient building services technology, the building impresses guests with a tangible level of occupant comfort. The educational concept at the Science College envisages integrating the building and its building services equipment into classes as a demonstration site. Both buildings meet the passive house requirements and received funding as “3-litre house schools” in the focus topic of “Energy-efficient schools” within the “Energy-optimised construction” research initiative of the German Federal Ministry of Economics and Technology. The school building will be subjected to detailed scientific monitoring in actual operation through to 2011.
The building is a model project in the EnOB research area of “Energy-efficient schools”. With the aim of improving the quality of teaching and youth education work, the building itself is intended to serve as a teaching

and demonstration site. This is why, in addition to the use of innovative technologies, energy themed teaching modules are also being developed.
The buildings are located in direct proximity to the remains of a historical four-sided courtyard at the edge of a landscape conservation area. The building developer wanted them to blend harmoniously into this environment and for a campus to be formed between the two buildings. As a continuation of the east wing of the building, the guest house shares the dimensions of the historic building. The Science College was built as a stand-alone building in the centre (of the former courtyard). In this U-shaped arrangement, the Science College stands out with its modern design and choice of materials. The building is slightly rotated with respect to the axes of the courtyard, with the result that on two sides of the buildings there are views of the panoramic landscape to the south, and on the north side a campus is formed between the old and new buildings.

Building concept

The building is designed as a concentric building structure that encloses a “forum”. The individual classrooms are arranged helically around this centre, rising 5-6 levels (over 2 storeys). The Science College is built of reinforced concrete as a solid construction. Only the area above the forum is a lightweight steel construction. The centre forum is a place to meet people, for independent study and for events. Smoke curtains allow this open space to fulfil all fire protection requirements. Three heliostats in the ceiling with mirrors that track the sun ’s position (“light fountains”) direct a controllable amount of daylight into the space. As a result it is possible to have a lot of daylight in the forum despite the very well insulated roof. By request of the client, the inner walls between the classrooms and the galleries are made of transparent, fire-proof glazing (F 30). This means that the rooms are lit by daylight from two sides.
The building’s external facade is insulated with a conventional thermal insulation composite system (30 cm insulation thickness, thermal conductivity group 040). The building envelope’s high insulation standard with a surface/volume ratio that is optimised as a result of the shape of the building reduces the specific transmission heat loss to 0.23 W/m²K. This is a basic requirement for meeting the 3-litre-house standard. The aluminium window frames are outside the concrete and were offset on bracket structures. As a result of the construction time, the windows were sealed air-tight at ambient temperatures of 0-5 °C and high humidity using weather strips, special adhesives and mechanical pre-drying. This work was highly complex and had to be redone repeatedly in some areas. The windows of the Science College are fitted with electrochromic triple insulating glazing (E-control glass). Depending on the switching condition, the glass changes colour from transparent to blue, and thus allows the light and warmth which permeates into the building to be controlled (light transmission TL: 10-45%; g-value 10-30%). As this glass had to be produced specially for the project, three standard window sizes were chosen for the building. This limited the costs.

Energy concept

The Science College’s energy supply is based on a low exergy system (LowEx). An earth-coupled heat pump system combined with a distribution system for concrete core temperature control allows heat to be used at a very low level (approx. 23 °C) and cooling at a very high level (approx. 18 °C). As a result, annual coefficients of performance in excess of 5 are anticipated for the heat pump. As a result of many small surfaces in the building geometry, the use of pre-assembled mats for concrete core temperature control did not prove suitable for this building, i.e. on-site fitting would have saved time. In accordance with the “Students heat their school” principle, i.e., a classroom must only be heated at the start of class, after which the heat given off by the students is sufficient to keep temperatures comfortable, there are no problems meeting the heat requirements. Excess heat from concrete core temperature control is used to heat water in the guest house via a second heat pump.

Cooling and ventilation

The building can be passively cooled via borehole heat exchangers with low, minimal use of auxiliary energy. In order to keep the energy consumption and hence the costs for summer cooling to a minimum, the original user requirements (room temperatures constantly below 26 °C with full occupancy and without night ventilation) were adjusted for the maximum cooling capacity of the borehole heat exchangers. If temperatures in excess of 26 °C are accepted for a maximum of 60 hours per year (approx. 4% of the year), the building can be passively cooled via building element activation and all that is needed is additional underfloor cooling in the simulation lab and to switch from normal computers to laptop PCs.
The ventilation system was intentionally designed so that the maintenance work required for fire and smoke dampers was minimised. The distribution lines are laid on the roof, and routed vertically downwards in shafts. The classrooms are ventilated via presence detectors. Supply air is fed to the lecture halls and seminar rooms. The exhaust air is extracted via the preparation and meeting rooms. This allows air quantities to be reduced.

Lighting

The lighting concept aims for optimum use of daylight in the forum and in the classrooms. The amount of daylight entering the forum is increased via light-diverting heliostat mirrors in the roof that track the position of

the sun. The classrooms which are partially transparent towards the forum facilitate educational interaction but above all they enable lighting from both sides.
This way, even when sun protection is used, a sufficient supply of natural light is guaranteed. Electrochromic, switchable glazing (E-control) is used in the Science College. This changes to a dark blue colour in bright sunlight, reducing the solar energy input and preventing overheating of the classrooms. When the sky is cloudy, the glazing becomes transparent again to allow a clear view. By request of the client, who wanted to evaluate the light atmosphere in operation, the building is prepared for subsequent retrofitting of external sun protection as a precaution.
The artificial lighting is controlled depending on the daylight. In addition, fluorescent lamps were installed in two special-subject classrooms that imitate daytime and seasonal colour temperatures. This is to allow the effects of light colour on learning to be researched.

Educational concept

The Science College offers German and foreign students the opportunity to take part in experimental and project oriented courses, seminars and workshops in scientific subjects. The following subjects are offered: mathematics, biology, chemistry, physics and engineering. The programme includes topical research areas such as biochemistry, neurological research, nanotechnology, materials, computer simulation and astrophysics.
The integration of the innovative technologies implemented in the building into the classes that are taught is a key aim of the school's directors. On the ground floor, students have access to computer workstations with modern software where they can track the current status of the building's functions and energy-saving measures and influence the parameters themselves. In this way, students learn how they can take simple steps to help save energy and minimise CO2. These insights can be incorporated into school projects together with the latest consumption data.
The involvement of students and teachers in the scientific monitoring enables reciprocal learning processes as the technological and educational experience gained by the Science College is made accessible to the accompanying research institutes. At the same time, partnerships with RWTH Aachen University, FH Aachen-Jülich, Forschungszentrum Jülich and the research departments of industrial companies help to make the current state of the art in scientific research accessible to the Science College, as a result of which the students enjoy excellent educational opportunities.

Performance

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

Optimisation measures and possibilities

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

Construction costs and economic viability

Private and industry sponsors invested over one million euros in the project. The construction costs came to 1,500 euros/m² (net, cost groups 300 and 400) and the costs of the fully equipped building including all teaching materials were 2,600 euros/m2 (total: 7.7 million euros). This was almost within the planned budget. Further information on this point may become available as the project continues.

Total implementation costs:

7,726,000 euros gross for the school and guest house building, of which:
Public funding from the German federal government: 1,030,702 euros
Public funding from the local state government: 3,992,000 euros
Own funds: 1,273,600 euros
Loan financing: 1,429,698 euros

Key energy data

Energy indices according to German regulation EnEV (in kWh/m²a)	
Heating energy demand	16.00
Overall primary energy requirement	68.00
Measured energy consumption data (in kWh/m²a)	
Site energy for heating and domestic hot water (dhw)	19.10
Total source energy	83.40
Lighting, tools, kitchen	13.00
Supporting electricity	11.00

Science College website
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.