Workshops for handicapped people

EnBau

Wood and glass define the appearance of the workshop for disabled people in Lindenberg.
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The workshops for handicapped people in Lindenberg (Germany) represent a good example of consideration and consistent implementation of energy aspects from the very onset, and this with reasonable costs. But at the same time, the real objective always remained in focus, namely to equip the rooms to suit the occupants and their special needs. The accompanying life cycle analysis which was conducted emphasises the holistic approach of the planning. Wood and glass define the exterior appearance of the workshops. The large glazed surfaces bring a lot of daylight into the rooms on the one hand, while on the other hand the accumulation of heat in summer, and the transmittance behaviour in winter, must be taken into account in the planning. The building concept addresses this with intensive passive utilisation of solar energy, in combination with simple sun protection mechanisms, high-quality insulation, and thermally active building element masses. The utilisation of renewable energy sources and an adapted ventilation concept, as well as measures for minimisation of electricity consumption, supplement the energy efficiency efforts with regards to the building services equipment. Thus, the building achieves a calculated heating requirement of 37 kWh/m2 p.a.

Building summary

Project status	Optimized
Location	88161 Lindenberg im Allgäu, Bayern
Completion	12/2004
Inauguration	1/2005
Building owner	Lebenshilfe für Behinderte e.V. (+ Betreiber und Nutzer)
Heated net floor area	4,315 m^2
Gross volume	25,160 m^3
Work places	180
A/V ratio	0.39 m^2/m^3
Key aspects	Glazing + windows, Daylight planning, Daylight systems, Ventilation + heat recovery, Regenerative + passive cooling, Heat pump, Control technology, operational management, building automation, Photovoltaics, Ecology of building materials

Project description

A number of ecological issues made the process of attaining planning permission long and drawn-out. For instance, slight contamination of the ground water put the use of the heat pump in doubt. Use of the water for the heat pump was indeed permitted, but conditions imposed by the authorities prohibited its return to the ground water afterwards. The water is now channelled into a nearby brook.

Building concept

The facility provides 140 jobs in various trades (expandable to 200), 40 office spaces, and a communal area. Naturally, it had to planned in such a way as to allow full access, and is thus largely at ground level. The facility was kept relatively compact by means of subdivision into several individual buildings, between which the workshop corridor and staircase form unheated buffer zones.

The workshops, in which many of the handicapped people will work for much of their lives, provide a high quality of space, due to large window surfaces, the natural construction material wood, and a well thought-out colour scheme. In addition, care was taken to establish a self-explanatory orientation: the high transparency of the rooms makes it possible to look into other areas, neighbouring rooms, and outdoors. Materials, colours and symbols aid navigation.

The facility is subdivided into two wings, with a front building to the east. A broad walkway with a glass roof, the so-called workshop corridor, connects the building sections. The ground floor houses craft workshops and assembly shops, with offices above them in the north wing. The two-storey front building houses the dining hall

with gallery and gymnastics room, the large kitchen, and a caretaker's flat.
For the building structure, facades and roof, purely wooden constructions were used, with cellulose insulation. The foundation slab is made of reinforced concrete, as is the two-storey technical area, which also serves to strengthen the construction. The windows to the south are double-glazed, while the remaining windows are triple-glazed. Skylights with translucent thermal insulation distribute daylight into the depth of the rooms. On the south facades, fixed PV modules between skylight and window on the upper storey serve as sun protection, as does coloured film between glass panes on the ground floor. The leaning, south-facing glass surfaces in front of the dining hall and the south wing are equipped with exterior shading systems. The workshop corridor is shaded horizontally from indoors. Light domes (south) and a skylight strip (north) with mirrored light shafts throughout the upper storey improve the supply of daylight for the 16 m-deep and 19 m-deep workshop rooms. All roofs are planted with vegetation.
Blower door tests showed air-tightness of n_{50}=0.6 h^{-1} for the heated building structure, and n_{50}=0.81 h^{-1} for the entire complex.

Energy concept

For heating, a ground water heat pump, and a pellet boiler which can also use waste wood from the carpentry workshop, serve to generate heat. Distribution of heat occurs primarily via underfloor heating and via radiant ceiling panels, which were selected for the workshop on the north side due to the use of forklifts. For heat evacuation in summer, water which has been cooled by ground water is passed through both systems.
The building is mechanically ventilated. One reason for this is the depth of the rooms, which in some areas is substantial. In all areas, in addition to the mechanical ventilation, the staff have the possibility of opening windows or ventilation flaps in the facade if required. To avoid having a separate ventilation system for the dining hall, volume flow controllers reduce the air volume in the workshops during breaks, and feed the supply air into the communal building.
One particular feature in winter operation is that the supply air flows into the unheated workshop corridor via the workshops, through adjustable slide-openings, and there it is extracted by suction through a central duct, and released outdoors via two-fold heat exchangers. Simultaneously, the temperature of the otherwise unheated workshop corridor is adjusted by the warm exhaust air. Solar yields in the workshop corridor are also used for heat recovery.
The intention is to keep all windows closed during summer, and only to ventilate mechanically for as long as the outdoor temperatures remain above the room temperatures. To this end, the supply air can be cooled via the ground water. If it is cooler outdoors, ventilation is to occur via windows. In areas at risk of overheating, such as the workshop corridor and the south-facing tilted glass surfaces of the dining hall and workshops, there are motor-driven louver windows which open automatically if the room becomes too warm. The ventilation flaps and skylights also open automatically.
Closed recessed balconies in front of the offices channel the warm air from the workshop corridor outdoors via the upper storey, due to their chimney effect. This prevents this warmth from entering the offices if windows are open. The ventilating recessed balconies can be reached from the offices via insulated interior doors. In winter, if required, the air which is heated in the workshop corridor by solar irradiation can flow directly into the offices if doors are open.

Performance

In the first two years of operation, the building achieved good energy characteristics, although not yet the planned values (fig. 8). One reason for this is that the systems operation and building occupancy do not always correspond to the presumptions made during planning and simulation. For example, the fact that the electricity required for lighting the workshops remains almost constant throughout the entire year indicates that the occupants require a higher light level than the level required by the Workplace Directive, because this latter level could be easily maintained in summer without artificial lighting. Solutions have been developed for various technical problem areas, and are to be implemented during the year 2007.

Optimisation measures and possibilities

On cold summer days, and in the transitional periods, the heat pump supplies the underfloor heating. At the same time, the pellet boiler operates only for the purpose of water heating, and thus exhibits low efficiency. In the future, the heat pump will be completely deactivated at these times.
The control of the louver windows is as yet solely dependent on the indoor temperature. Thus, it is often the case that outdoor air which is too warm enters the building in summer. Similarly with regard to ventilation behaviour, it is evident that the windows are also opened at times when the outdoor temperature is higher than the indoor temperature. Now, a "ventilation signal light" in the workshop corridor is to indicate whether the facade flaps should be opened or closed.
The flexible sun protection for the south wing / dining hall area does not function sufficiently well: at the

moment, it is mainly operated manually, and coupling to the overall irradiation has not been realised. Now, the sun protection is to be controlled automatically, with the option of subsequent manual adjustment. In addition, for days when the sun is low in the sky, the originally planned interior glare protection is to be retrofitted.
The south-facing workshops become too warm in summer, for reasons such as those mentioned above. Furthermore, the thermal separation of the sunroom (tilted glass surfaces in front of the south wing) with a glass wall, as intended in the planning phase, was not implemented, due to a request from the contractor, although this would be advantageous for the interior climate right throughout the year. For the time being, the ventilation, underfloor cooling, and radiant ceiling panels are to operate continuously on "extreme" days.

Construction costs and profitability

Economic-ecological calculations accompanied the planning throughout the entire life cycle, with the aid of the integral software program LEGEP. As fundamental alternatives, the planned low-energy-standard wooden construction ("energy-optimised") was compared with a conventional solid construction in accordance with the EnEV German Energy Saving Ordinance standard ("reference"). The criteria were costs, energy requirement, and environmental impact of construction, operation, and demolition.
This showed that additional costs of less than 6% for the planning and construction of the building as a wooden construction greatly reduces the environmental impact, both in the construction phase and in the occupancy phase. In a short space of time, the low energy requirement and the utilisation of renewable energy sources already lead to a considerably lower environmental impact than that of a conventional building, and this in conjunction with lower energy costs. Given an annual energy price increase of 5%, it was calculated that the higher initial investment would amortise in 15 years.

Key energy data

Energy indices according to German regulation EnEV (in kWh/m²a)	
Heating energy demand (simulation, based on heated net floor area)	37.00
Overall primary energy requirement (simulation, based on heated net floor area)	82.00
Measured energy consumption data (in kWh/m²a)	
Thermal heat consumption (in 2006, based on heated net floor area)	40.40
Total source energy (in 2006, based on heated net floor area)	107.80
Hot water	4.00
Heat pump	4.00
Measurement and control technology	15.00
Fans	13.00
Lighting	5.00

All data of 2006 and in terms of final energy, based on heated NFA. "PV" is in kWh/a.

Implementation costs

Costs of implementation in €/m²	
Construction (KG 300)	758
Technical system (KG 400)	319

These figures represent established costs
Net construction costs (according to German DIN 276) relating to gross floor area (BGF, according to German DIN 277)

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information at www.enob.info.