Käthe Kollwitz School, Aachen

EnSan

A typical classroom situation is that while some complain of a draught, others ask for more fresh air. And the shading, intended to guard against glare and heat penetration during summer, makes the room so dark that the lighting needs to be switched on far too often. This was also the case in the Käthe Kollwitz School in Aachen (Germany). The school, built in 1951 and extended in 1995, had passed its prime. A comprehensive building refurbishment was seen as the way to improve classroom conditions significantly, while reducing energy costs.

The entrance area.
© Stadt Aachen

Building summary

Project status	Optimized
Location	Bayernallee 6, 52066 Aachen, Nordrhein-Westfalen
Year of construction	1951
Refurbished	2003
Building owner	Stadt Aachen (+ Betreiber, Nutzer)
Gross floor area	8,737 m²
Key aspects	Heat insulation, Optimised lighting, Ventilation + heat recovery, Combined heat and power generation, combined heating and cooling, Control technology, operational management, building automation

Project description

The Käthe Kollwitz School is a vocational college with 2,200 students and 85 teachers. Subjects taught include home economics, gastronomy and social studies; accordingly the building includes kitchen classrooms and a laundry. This has an effect on energy consumption. The building has two (in some areas three) full storeys, with a cellar beneath most of the building. The form and structural design are typical of the era in which it was built. The appearance is determined by an interplay between a perforated facade and a horizontally divided facade. With windows accounting for approximately 67% of the outer surface, the school's facade is generously glazed. The exterior walls consist of a single layer of 36.5 cm and 49 cm bricks, partly implemented as exposed brickwork on the outside, while the inside is plastered. In the radiator niche areas, the walls are only 14 cm thick.

Refurbishment concept

During refurbishment, the combination of two different facade structures was retained, and interpreted in a modern way. Now, areas with a thermal insulation composite system alternate with facade sections made of hung brick elements. Each has 12 cm-thick insulation. Thermally insulating glazing with frames made of wood and aluminium replaces the original single-pane wooden windows. The roof was insulated with 20 cm-thick cellulose fill. In the first construction stage, in the cellar, which also was previously not insulated, insulation was applied to the cellar ceiling. Parts of the cellar walls were insulated on the inside in areas with interior temperatures of 20°C. In the second and third construction stages, insulation measures were not implemented here. Partly for construction-related reasons, and partly due to cost-benefit considerations, some thermal bridges were also consciously accepted: for example, the base remained uninsulated, and no changes were made to the 4-to-5 cm-thick thermal insulation in the areas with no cellar.

Energy concept

Heating: although the existing gas-powered twin boiler system was indeed state-of-the-art, efficient control of the system and hydraulic compensation were impossible or only possible with great difficulty, due to the single-pipe heating system which was in place. As the location in a health resort area is declared a priority area for remote heating, it was possible to convert the heat supply to remote heating. Already in the first construction stage, the entire building was connected to remote heating based on combined heat and power generation. Heating circuit distributors, pump technology, and the centralised control technology were renewed. The piping network was converted from a single pipe, to a two pipe system. In so doing, it was possible to continue using most of the old pipes. Approximately 40 percent of the ribbed radiators could then be removed due to the reduced heating requirement.

Ventilation: originally, only the kitchens were equipped with a ventilation system. During refurbishment, ventilation systems were installed in all classrooms, whereby the system, control method, and heat recovery differ between the various construction stages. This now enables a comparison of the different systems.

Lighting: much of the lighting system was out of date. 60% of the classrooms did not reach the light level required by the German industry standard DIN 5035. For this reason, the lighting in all classrooms and corridors was replaced by mirror louvres with electronic dimmable ballasts, most of which are controlled in a daylight-dependant manner.

Performance

In total, the refurbishment lowered the end energy requirement for room heating, water heating, and ventilation by 65%. The continued increase in electricity consumption due to improved utilisation of the school, and due to the installation of computers, was counteracted by electricity-saving measures (10% reduction).

Measurements taken during short periods in several classrooms showed CO_2 concentrations of up to 5,000 ppm where only window ventilation was used. Where mechanical ventilation was used, at just 16-17m³/h per person, in conjunction with quick ventilation via all windows during breaks, CO_2 content of 1,500 ppm (the DIN 1946-2 threshold value) was never exceeded. The electricity consumed by lighting was almost halved.

Optimisation measures and possibilities

The intensified fire and smoke protection standards have proven to be critical issues with regard to the ventilation planning. In some areas of the first construction stages, smoke detectors had to be upgraded. In order to minimise inspection and maintenance costs, ventilation systems were to be conceived in such a way as to minimise the number of technical components requiring obligatory maintenance, by means of prudent positioning and structural integration of ventilation components.

Examination of various ventilation strategies with mechanical ventilation systems showed that the outdoor air volume flow of 30 m³/h per person, as required for ventilation of classrooms by the DIN standard, is rather high. Even with an air volume of 17 m³/h per student, in conjunction with ventilation during breaks, indoor air of good quality was achieved in classrooms. If these values, derived from experience, are adhered to, electricity consumption reduces, and the ventilation system could have been made smaller from the onset. However, the contractor must agree to a design which deviates from the DIN specifications.

The implementation of LON components in conjunction with standard building services equipment proved cost-intensive and very susceptible to faults. Comparatively simple technical control tasks, which arise in schools, should be performed using appropriately simple technology. In any case, testing of functionality is always important. Initially, such tests should be performed thoroughly; later, occasional spot checks should be made.

Construction costs and profitability

The refurbishment costs amounted to approximately 2.8 million euros.

Key energy data

Measured energy consumption data (in kWh/m²a)	before refurbishment	after refurbishment
Thermal heat consumption	177.00	63.00
Total source energy	195.00	47.00
Electricity requirement before refurbishment (2001)	177.00	63.00
Electricity requirement after refurbishment (2004)	17.00	15.00

Refurbishment costs

Refurbishment costs in €/m²	
Refurbishment costs (over all)	316
Exterior wall	44
Windows and doors	87
Building services equipment	83
Planning costs	62
Other building costs	16

These figures represent established costs

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.