

# Jülich research laboratory



Laboratory buildings usually have very high energy consumption. This is partly due to the special occupancy conditions, with a high ventilation requirement, and high electricity consumption for devices. Furthermore, the buildings bear evidence to the fact that due to the institute's changing scientific tasks, the usage of the rooms was changed frequently. Office rooms were converted into laboratories, and vice versa. Due to the fact that many research institutes' buildings were built as early as between 1950 and 1980, the building fabric now exhibits substantial shortcomings. The building services equipment is out-dated and not sufficiently adapted to the frequent changes in usage.



The facade of the research institute after the exemplary refurbishment.

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## Building summary

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| <b>Project status</b>                        |  |
| <b>Location</b>                              | Wilhelm-Johnen-Straße, 52428 Jülich, Nordrhein-Westfalen   |
| <b>Year of construction</b>                  | 1967   |
| <b>Refurbished</b>                           | 07/2003  |
| <b>Building owner</b>                        | FZ Jülich (+ Betreiber und Nutzer)   |
| <b>Gross floor area</b>                      | 3.720 m <sup>2</sup>   |
| <b>Gross volume</b>                          | 11.420 m <sup>3</sup>  |
| <b>Usable floor area (according to EnEV)</b> | 3.380 m <sup>2</sup>   |
| <b>gross floor area</b>                      | 3.720 m <sup>2</sup>   |
| <b>A/V ratio after refurbishment</b>         | 0,30 m <sup>2</sup> /m <sup>3</sup>  |
| <b>Key aspects</b>                           | Daylight planning, Optimised lighting, Ventilation + heat recovery, Active cooling, Regenerative + passive cooling |

## Project description

"Building 06.2" in Research Centre Jülich was built in the mid-1960s as a chemistry laboratory, and in 2002 was to undergo modernisation for future use by the Institute of Phytosphere Research. Before the refurbishment, the building had a primary energy requirement of around 1,200 kWh/m<sup>2</sup> p.a. After an appraisal of the building, and short-term consumption measurements, a refurbishment concept was developed and implemented. A reduction of the primary energy requirement by at least 50% was targeted. Use of the laboratory recommenced in 2003. In a scientific measurement and optimisation programme, the consumption data was collected and analysed until the year 2005.

### Refurbishment concept

In the refurbishment, a cooling ceiling system was used for the first time for climate control of physical measurement rooms. The individual rooms were allocated fixed functions as chemistry laboratory, physical measurement room, or office and seminar room, and were combined in groups within the building. Thus, it was possible to keep the connecting lines short. Handling of materials which are hazardous to health is now only possible in the designated chemistry laboratories. Thus, the number of rooms with high air renewal is reduced. Rooms with high waste heat loads were housed on the north side of the building.

For improved utilisation of daylight, exterior blinds with light-diverting louvers, daylight openings in corridor doors, skylights, and a changed colour scheme were implemented. The effect of the light-diverting louvers on the impression of space, and the corresponding shading situation, were examined by means of light simulation. The removal of the emergency exit balconies also improved the daylight situation. The new lighting system features energy-saving bulbs, demand-oriented control with presence detectors, level switching, and daylight-dependent light level control.

The balconies' "cantilevers" were removed in order to reduce the thermal bridges, and to achieve a smooth facade. With the refurbishment of the building envelope, heat transmission losses were halved, and the air-tightness was significantly improved. This is confirmed by the blower door test at the end of the construction

phase, with a value of 0.98 h<sup>-1</sup>, which is considerably better than the value required by the German Energy Saving Ordinance (EnEV) of 1.5 h<sup>-1</sup>. In order to ensure the necessary fire protection and laboratory safety after the refurbishment, the storeys were divided into several fire compartments, and separated by smoke control doors and firewalls. Improved structural fire protection and electrical acoustic alarm devices also serve for this purpose.

### Energy concept

In the future, 85% of the exhaust air will be channelled through a centralised air extraction system with heat recovery, which at full load can recycle 50% of the contained heat. In addition, four decentralised systems are provided for exhaust air with high solvent content.

Climate control of the laboratory rooms is still necessary, due to the waste heat from devices. With the refurbishment, outdoor air coolers were installed for "free cooling", as was overnight ventilation, and a supplementary water-carrying cooling ceiling system in the measurement rooms. This considerably reduces the electricity requirement for ventilation. To this end, depending on the heat load, three systems are used: a surface-mounted cooling ceiling system, a gravity cooler, and fan convectors. All systems are designed for slight temperature differences, to enable the use of surface water and environmental heat. During operation, it is preferable to cool the solid slabs at night.

For room-specific control, variable volume flow controllers are implemented, and individual room balancing is conducted. Air renewal at night and on weekends is reduced according to fixed pre-defined time periods. Presence detectors in the individual laboratories guarantee that the ventilation system immediately switches to daytime operation when required. At the normal laboratory extractor hoods, operation of the front sliding panel automatically causes increased air extraction. Vacuum extraction takes place constantly in the solvent cabinets. A control system balances all exhaust air flows, and automatically feeds in the volume of supply air necessary to maintain the pressure. Only energy-saving, speed-controlled fans are used. With these measures, the air volume flow can be reduced by more than 50%. In the library, which also serves as a seminar room, the air quality is controlled by means of a system with an air quality sensor.

### Performance

Accompanying measurements of the laboratory were taken until 2005. Special attention was paid to the empirical measurement of actual occupancy behaviour with regard to the simultaneity factors in the usage of the rooms, equipment and devices. Initial results from the heating period 2003/04 indicate heating energy consumption of 133 kWh/m<sup>2</sup> p.a., which is above the predicted requirement. The ventilation system has largely achieved the predicted values, although the electricity consumption of the fans has as yet been higher than expected. Here, the system has been fine-tuned in order to reduce the fans' electricity consumption, and also the energy consumption for heating and cooling.

### Key energy data

| Energy indices according to German regulation EnEV (in kWh/m <sup>2</sup> a) | before refurbishment | after refurbishment |
|--|----------------------|---------------------|
| <b>Overall primary energy requirement</b>                                    | 1.235,00             | 600,00              |
| Measured energy consumption data (in kWh/m <sup>2</sup> a)                   | before refurbishment | after refurbishment |
| <b>Electricity (based on MFA)</b>  |                      | 39,00               |
| <b>Heat (based on MFA)</b>   |                      | 29,00               |
| <b>Cooling (based on MFA)</b>  |                      | 146,00              |