D5

University of Ulm, Germany

1 Photo

Figure 1: University of Ulm

2 Project summary

University buildings normally use very sophisticated HVAC systems. Frequently, these systems have to be adapted to the actual user needs. If this is not done on a regular basis energy consumption increases. The adaptation of the systems can usually be financed through contracting.
The renovation of the HVAC system of two buildings of the University of Ulm offers an impressive example of an application of this type.
The two 5 storey buildings were built in 1967 and 1983 for the biological and the medical faculties respectively. The technical systems originate mainly from 1971. The building facilities include offices, laboratories, central mechanical workshops, classrooms, a kitchen with cafeteria and a dental hospital.
The project described concentrates only on the technical systems. No retrofit of the building envelope was undertaken.

3 Site

Oberer Eselsberg Ulm, Germany
Latitude: 48°23' N. *Longitude:* 10°0' E. *Altitude:* 522m
Temperate Climate
Mean annual temperature : 8.5°C
Mean winter temperature : 3.7°C

4 Building description /typology

4.1 Typology / Age

Mega–structure university building. 1967
Educational level: University, graduate studies

4.2 General information

Year of construction:	1967 / 1983
Year of renovation (as described here):	2000
Total floor area (m^2):	19900/9100
Hours of operation:	12 hours a day, 260 days a year

Some systems have to be operated 24 hours a day.

4.3 Architectural drawings

Not available

5 Previous heating, ventilation, cooling and lighting systems

Systems were almost 30 years old. System controls were completely out of date. Some of the spare parts required for maintenance were unavailable, thus a general retrofit had to be carried out anyway to guarantee proper operation of the building.
The figure gives an impression of the Control Station before retrofit.
This situation seems quite typical for many case studies considered in Annex 36. In such cases energy contracting as part of the retrofit project can make a substantial contribution to the whole retrofit budget.

6 Retrofit energy saving features

6.1 Energy saving concept

Rebuild of the control and DDC techniques of the building.

6.2 Building

None

6.3 Heating and Ventilation

The following list of measures should be considered as an example only. It gives typical measures which proved to be cost-effective in the University of Ulm project whilst in other buildings similar measures have to be identified according to their actual state and operation. In this case, the adaptation of the HVAC systems to the user needs and the operation of the systems according to the actual situation needs, proved to be most effective.

Measures applied in Ulm:
Retrofit of DDC Control (see figure for renovated system)
Installation of new DDC System
Installation of 250 temperature sensors to measure heating needs
Replacement of oversized motors for ventilation
Optimisation of ventilation strategies
Utilisation of internal heat gains
Optimisation of heat recovery
Optimisation of cooling and heating according to actual user requirements
Continuous energy monitoring
Continuous training of operators

7 Resulting Energy Savings

Energy costs before retrofit: €1.000.000 Inc. VAT
Energy costs through retrofit: €1.000.000 Inc. VAT
Energy savings after retrofit: €400.000 in first year after retrofit

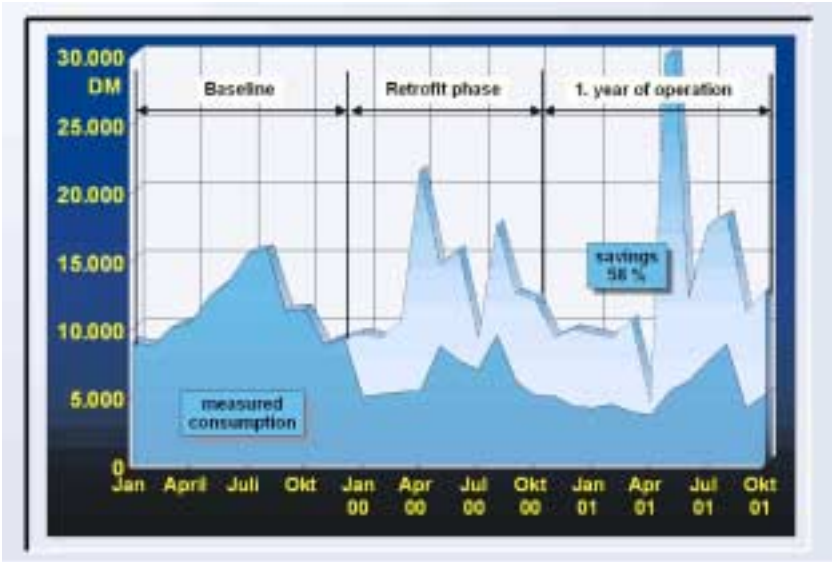
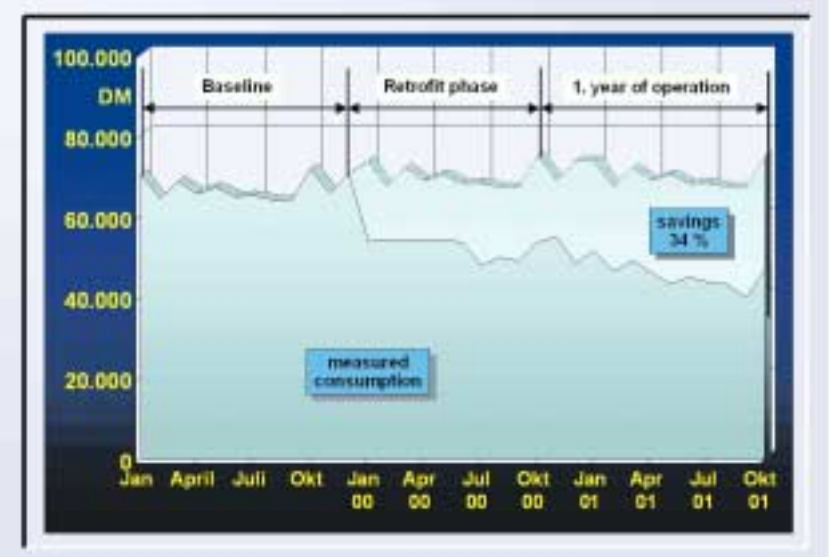


Table 1: Cooling costs before, during and after retrofit. Savings in 1st. Year: 58%

Table 2: Heating costs before, during and after retrofit. Savings in 1st. Year: 40%

Table 1: Electricity costs before, during and after retrofit. Savings in 1st. Year: 34%



8 User evaluation

Owners, operators and users appreciate the new operation which fully meets their needs. The university now plans to renovate the remaining buildings on the same basis.

9 Renovation costs

Systems retrofit: €1,200,000
In addition €1,100,000 were invested by the building owner to modernise components not related exclusively to energy savings.

System operation (energy management and financing): €74,000

10 Experiences/lessons learned

It will take only 3.66 years to pay the invested amount back from energy savings.

10.1 Energy use

Efficient operation can save up to 40 % of total energy.

10.2 Practical experiences of interest for a broader audience

The experiences described in this chapter are derived from various contracting projects and apply for this case study as well.
Operation of HVAC systems in most educational buildings is far from being efficient. This results in efficiency numbers which are up to 100% higher than expected.
Adaptation of system operation to user requirements is a very cost-effective measure, which can be afforded even if no other renovation measures are possible.
Adaptation of system operation to user requirements should follow other retrofit measures. Usually only this will guarantee the planned energy savings are achieved.
Commissioning of systems after retrofit seems mandatory.
Energy management should be initiated after retrofit. Energy management will be the basis for a long term reduction of energy costs.
Training of operators is required.

10.3 Resulting design guidance

Best results can be achieved by combining retrofit and contracting
Contracting could include:

- Installation of energy management
- Optimisation of the system according to user requirements
- Commissioning of the system
- Guarantee of predicted savings with unchanged comfort conditions
- Control of energy usage and continuous adaptation
- Maintenance of optimised system
- Control of comfort conditions

Retrofit should also include measures which are too expensive to be included into contracting but which are required for other reasons.

11 General data

11.1 Address of project

University of Ulm,
Staudingerstraße 4,
89081 Ulm

11.2 Project dates

Project initiation: 1996
Design completed: 1998
Renovation construction completed: 2000
Monitoring and evaluation completed: Continuing

11.3 Date of report / revision no.

June 2002

12 Acknowledgements

Builder: University of Ulm
Architect: *not relevant*
Engineer: Axima Württemberg GmbH
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National, international support programmes: None, the project was completely financed by energy savings.

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13 References

None provided