Hochschule Offenburg
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Energy Monitoring and Innovative Building Automation - Demonstrational Building: Solar Info Center Freiburg/Germany

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The research programme EnBau:MONITOR (within the framework programme EnOB, Energy Optimised Building Construction) supported by the German Ministry of Education and Research (BMBF) yields to the research on recently constructed non-residential buildings focussing on the potentials of reduction in energy demand implementing renewable energy systems. In the first phase of the programme new energy concepts are implemented for planning and construction of new buildings. The second phase is related to the validation of the energy concepts by performing a monitoring, showing optimisation potentials and fulfilling defined values for the maximum allowed heat consumption with 60 kWh/m²/a for space heating or the total primary energy consumption with 100 kWh/m²/a. A concomitant research evaluates the approximately 25 new buildings taking into account the specific building characters but working out common parameters for benchmarking.

The EnBau:MONITOR project „Long Term Monitoring of the New Building Solar Info Center (SIC) Freiburg" started in June 2004 and terminated in January 2008. The main topics of the research work were the following energetic characteristics:

- Natural Climatisation with night ventilation.
- Cooling of a big seminar room and the lounge by borehole heat exchangers.
- Zone oriented switching and optimisation of the heating.
- Optimisation of the ventilation.
- Shading system.
- Analysis of power consumption and the total energy balance.
- Energy demand analysis.
- Elaboration of a „Building Operation Manual".
- Short term room comfort measurements.
- Building automation as part of the optimization process.

The constructional phase of the SIC-Building ended in 2003. The project duration was planned to be three years with a data acquisition period of at least two years. In the mid of the year 2005 the building occupancy was about 73 % and raised up to 95 % at the end of the monitoring project. On about 14.000 m² office, exposition and seminar areas, workshops, gastronomy and production already established as well as newly founded companies offer innovative products and services all around the development, distribution and introduction of renewable energies.

After three years of monitoring there is a good availability of data given with a coverage of over 95 % from December 2004 to January 2008. The total number of data points collected via building automation is 1109 of which about 584 were stored at a 10-min-resolution, the others were stored in an event logfile. Additionally weather data of the Fraunhofer Institute ISE in Freiburg were supplied for analytic evaluation on climatic influences.

Looking at the performance of the monitoring, in the first year smaller problems remained of the constructional phase and building control mismatches were solved. Further on additional sensors and counter meters for heat and power had to be integrated to the data acquisition network to get an adequate evaluation for the energy balance of the building. The monitoring activities were performed together with R&D works within the zafh.net. Modern communication paths and web services were introduced to improve building monitoring and optimisation of the energy performance. The realisation of an online-access to the host computer of the building automation via internet and an OPC-Server offered an ideal infrastructure for optimisation functions based on the intelligent dynamic Building Operation developed by the zafh.net group in Offenburg. A new operation strategy for the night ventilation was tested in Summer 2006 in one part of the building and succeeded in 38 % of reduced electric

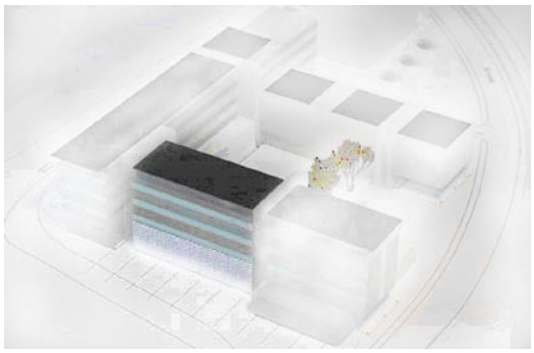

Figure 1: Analysed Zones for the optimization of the night ventilation.

power for the ventilator of an air duct compared to a conventionally operated adjacent air duct. The success led to an application of the strategy for whole building. Once installed the additional costs for the weather forecast supported operation are given with the purchase of the forecast data.

The evaluation of topics like shading units, operation of the space heating and ventilation, led to changes of parameters and thresholds for a better matching of processes like the start-up and shut-down of the heating. A special example is the improvement of the operation of the big seminar room "Music". The manual operation led to a continuous operation of the ventilation in winter and summer. Very high energy consumption in power and heat was the result. Supplying additional information to the user and an improved control panel had immediate effects with a better performance. Unfortunately the comfort during ventilator operation was still not satisfying so that more optimization efforts had to be done.

The solar supported warm water supply with five central warm water tanks and distribution to the single units could not be considered as recommendable. The evaluations of the monitoring data showed high circulation losses at low consumption rates. Warming up the water with small units close to the water outlets seems to be a more efficient solution for office buildings.

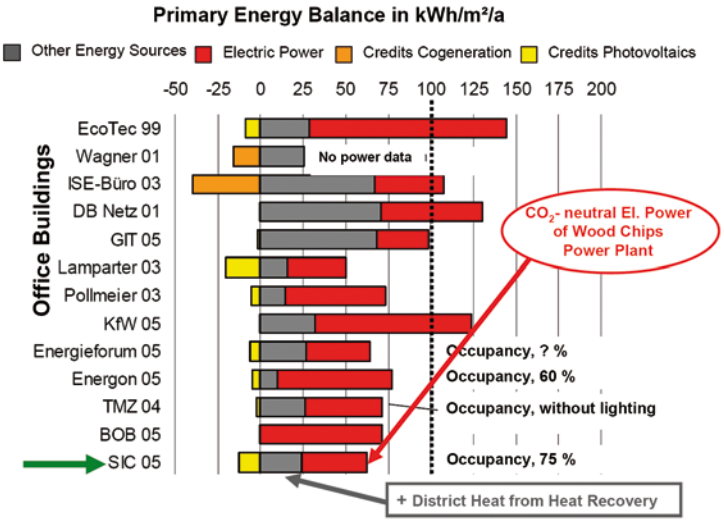

Figure 2 : Primary Energy Balance of the SIC within the EnOB research programme.

The energy balance of the SIC building fulfilled already at the beginning the restrictions given by the EnOB programme. With the optimizations, energy specific benchmarks were reduced even with the parallel raising of occupancy. The emission-free heat supply concept succeeded in saves two times more than the values of planning. The specific energy for

Figure 3: Grid connected PV generator on top of sic office building at Freiburg

space heating is about 30 kWh/m²/a calculated with a reference surface of 12.272 m². The CO_2 emission-free concept for the power supply did not fully succeed due to changes in operation conditions. First the wood chip power plant did not work properly to deliver the confirmed power, then the owner of the SIC building decided in 2006 to change the power supply structure from one single supplier (local utility) for the entire building to free choice of the power supplier for every leasable unit. The total power consumption of the building is about 600 MWh with a share of about 16 kWh/m²/a only for building operation i.e. lighting, ventilation, heating (electric power), elevators and other appliances.

The Solar Info Center can be considered as one of the best practiced demonstrational objects within the EnOB Programme. It can easily be taken as an example for the successful realisation of a new building being economically competitive and fulfilling strong energy efficiency criteria at the same time.