ECO BUILDING CLUB

Energy Retrofit in Stuttgart Vaihingen

- European demonstration project “Bringing Retrofit Innovation to Application in Public Buildings”

Demonstration Project Brochure

Innovative application

- High insulation
- CHP
- Mechanic ventilation with heat recovery
- Lighting System
- Solar PV

General information:

- Project developer:
- Location: Plegeheim Filderhof, Filderhofstreet 1, 70563 Stuttgart
- Project starting date: 2005
- Project status: finished in 2008

Summary of project:

BRITA in PuBs project (Bringing Retrofit Innovation to Application in Public Buildings) is an EU-supported integrated demonstration and research project, funded within the EU 6th Framework Programme. The project aimed to increase the market penetration of innovative and cost-effective retrofit solutions to improve energy efficiency and use renewable energy in public buildings all over Europe.

The exemplary retrofit of 8 demonstration public buildings in four European regions (North, Central, South, East) has been realised through the project. Different types of public buildings have been selected, such as colleges, cultural centres, nursery homes, student houses, churches etc.

The demonstration case considered here is one of eight buildings retrofitted within the project BRITA in PuBs. The building is located in an urban surrounding in the south of Stuttgart (Germany) and used as a nursery home.

The building was built in 1890 and was extended in 1952 on the right hand side of the entrance. As the energy consumption of the building was very high in comparison to the public building stock of Stuttgart, the project planted to implement energetic retrofit of the building.

The retrofitting solution includes: changing windows, insulating walls, installation of a new heating system integrated with solar plant, rebuilding whole lighting system, as well as installing a PV plant.

Description of project

The nursery has been renovated through the project. In order to reduce the energy consumption of the building, the windows have been changed, the walls insulated, a new heating system with solar plant was installed, the lighting system was completely replaced with high energy performance one, moreover, a PV plant has also installed.

After the retrofit the floor area of the existing building was reduced to 2102 m² since part of the building was torn down and replaced; an atria was designed between the existing building and the new building wing. The building after and before the retrofitting are shown in the figures below.

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The nursery before retrofitting

The nursery after retrofitting

European Project “Eco-Building International Club for advanced European sustainable energy technology dissemination in Europe and China”

Project partners:

ENEA (IT), ISNOVA (IT), FINCO (IT), ADEME (FR), AIMCC (FR), DTI (DK), DI (DK), CRES (GR), EBHE(GR), GPREC (GR), SEC(B), ZERI (CN), CBEEA (CN)

SIXTH FRAMEWORK PROGRAMME

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Insulation before retrofitting and retrofit measures applied

All building components (roof, upper ceiling, cellar ceiling and walls) had no adequate insulation before the retrofit. The U-values are assumed in table 1.

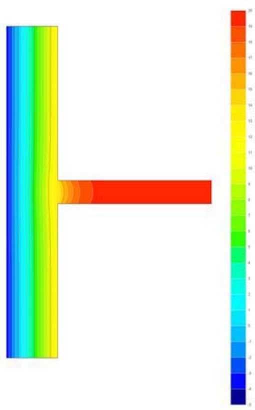
Table 1 The U-values of different components before and after the building retrofit

Element	Before insulation U-value [W/m²K]	After insulation U-value [W/m²K]
windows	3,0	1.0
walls	1,4	0.2 / 0.56 [internal/external ins.]
roof	1,0	0.2
upper ceiling	2,0	0.2
cellar ceiling	1,9	0.5

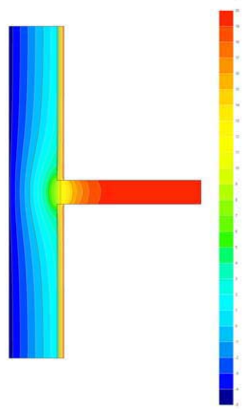
Originally the project intended to insulate the external walls on the outside façade by use of a composite insulation system (polystyrene insulation with plaster as cover). To keep the architectural characteristics of the building (frame of the entrance door, balcony, foundation of the building), the external insulation has been replaced by an internal insulation on most parts of the external walls. Finally, only about 20 % of the front wall got an external insulation. Because of the internal insulation at the front walls a lot of technical details had to be solved in order to eliminate thermal bridges. During the planning process the ways to apply vacuum insulation were investigated. Unfortunately the vacuum insulation couldn't be adopted in the project, because no system was suitable due to the characteristics of the building.

Upper ceiling

Without insulation Ca. 13,0-13,2 °C



With 5 cm insulation Ca. 12,6– 12,8 °C



All the **windows and entrance doors** have been retrofitted. The new windows have **high efficient glasses** with an U-value of 1 W/m² K and thermal spacers to minimize the thermal bridges at the edges. The refurbishment of the windows has been implemented completely, however, the roof could be insulated like initially planned due to constructional reasons. The insulation is on top of the rafters instead of under and between the rafters. Only a part of the upper ceiling (figure above on the right) was insulated at the top of the cellar. The other areas, like kitchen and dressing room, got an insulation at the base floor and insides of the external wall.

Heating, ventilation, cooling, lighting systems before retrofitting

The heating system was built in 1952. The boiler with a thermal heat power of 276 kW was replaced the first time in 1988, and then again due to some aspects, such as:

- the effectiveness of the furnace lays only by 88 %,
- the heating system had an old measurement control system. The preheated water went to the radiators at 80 °C.
- the boiler system did not work very efficiently because of the dropping insulation and the missing control system.

In order to reduce the heating supply, the old heating system has been replaced completely. A **combined heat and power** (figure on the left) unit with an electrical power of 18 kW and a thermal power of 34 kW has been installed.

The project aims at promoting and widespread disseminating EU innovative Research and Technology Development and Demonstration results, as well as eco-sustainability criteria in building sector, which include:

- energy efficient building materials, components and systems not yet introduced into the building market or in their first market phase;
- innovative applications of heating/cooling and power supply technologies, combined with the use of renewable energy sources, in building sector;
- best EU demonstration eco-building projects.

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Moreover two condensing boilers with 150 kW and a thermal solar plant (60 m²) complete the heat supply. The system temperature of the radiators was reduced to 60°C/40°C.

Before retrofit, the **ventilation** was possible by opening the windows. No mechanical ventilation system was installed. To transport the humidity away from the new bath rooms, a ventilation system has been installed. The air into the building is put into the plain. Further, under the entrance doors is a small split. Thus the air can flow into the rooms and the humid air in the bathrooms will leave the building. To reduce the ventilation losses a heat exchanger is included in the mechanical system. At the programmed time the ventilation system is started to run with a heat recovery rate of 60%. During summer, as cooling system is not necessary for this type of building in the German climate, the rooms are ventilated by opening the windows.

The old lighting system didn’t work very efficient. The system consisted of energy saving fluorescent tubes and bulbs in the rooms and the traffic areas. The install power of the installed lighting system was up to 12.5 W/m² for 300 lx. It was controlled by manual switch on/off. It is shown in figure on the right exemplary. A new energy-efficient lighting system was installed through the project. All lamps have been replaced with electrical ballasts instead of mechanical ones. Near the windows the lamps are controlled in function of the daylight. The installed electrical power of the new lighting system was reduced to 2.5 W/m² and 100 lx.

BEMS: The energy management system of the building has two components. First a conventional control system in the building was installed. It controls the water temperature of the heating system in dependence of the surrounding temperature and the room temperature. In dependence of the heat consumption, the control system has to decide, from which energy source the heat is produced: from the combined heat and power unit, from the condensing boilers, from the solar plant or from the storage tank. Finally the BEMS settle on, when the storage tanks has to reloaded and when the combined heat and power unit has to reduce its power.
Additionally the Stuttgart’s energy control model (SECM) is used, to control the daily energy consumption of building. With this system, the energy mangers in the office of environmental protection are informed automatically if the consumption is to high. Thus a long-term controlling instrument is installed.

Photovoltaic plant: The roof of the atria was modified to reduce the costs. Therefore the fraction of glass is reduced to a minimum. Thus the PV-integration of 100 m² in the glazed parts was impossible and the PV was integrated in the opaque roof. During the planning process, various applications of PV systems were investigated according to their efficiency, costs, architectural appearance. The PV installation area of 100 m² wasn’t reduced and consequently the energy gains by the PV-system are higher than originally expected. The produced electricity is used in the building. If the production is higher than the use in the building, the electricity is put into the grid.

Performance

Insulation after retrofitting

The building construction was guided by the architect and the building physician. By a finite element calculation the temperatures in the wall are quantified to assume the possibility strength of the insulation in the inside of the wall. The table 1 above shows the transmittance values of U for each kind of building component before and after the retrofitting.

Heating, ventilation, cooling, lighting efficiency systems after retrofitting

Energy saving measures, heating, cooling, ventilation	[kWh/m^{2}a]	Total [kWh/a]
High efficient windows	20	42.600
Insulation of the opaque elements	80	167.400
Ventilation	39	82.500
Heating system	46	95.900
Solar heating system	11	23.400
Total heating energy savings	196	411.800
Heating system (CHP)	37	78.800
Efficient lighting	10	21.300
Daylighting transfer	3	6.400
PV-system	7	13.700
Total electrical energy savings	57	120.200

Table 2

Eco-Building Club: an innovative RTD&D results’ promotion approach

Different from common market promotion approaches, where market operators are only simple message receivers, the project proposes an innovative approach: Eco-Building Club is a virtual round table, around which building market operators will be main actors for market penetration of research and demonstration results, through the following actions:

- determining what are more appropriated innovative RTD&D results for local market transferring;
- demonstrating the feasibilities of the research and demonstration results on real cases.transferring actions.

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Energy saving measure/ Saving investment/ savings/ payback	Total costs [EUR]	Eligible costs [EUR]	Saving [EUR/a]	Pay-back periods [a]
high efficient windows	82.800	82.800	1.900	43.6
insulation (wall, roof, basement)	246.700	228.400	7.400	30.9
Ventilation	99.800	67.800	3.600	18.8
heating system	279.100	176.900	15.000	11.8
solar thermal DHW	30.000	30.000	1.000	30.0
efficient lighting	213.000	85.200	2.900	29.4
daylighting transfer	20.000	20.000	900	22.2
PV-integration	98.000	98.000	7.000	14.0
Total	106.9400	789.100	39.700	19.9

Table 3

Information on project developer

Further information:

Name of project owner	City of Stuttgart
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City	Stuttgart
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Country	Germany
Contact person	Mr. Jürgen Görres
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