Gebhard Müller School

- European dissemination project "European high quality Low Energy Buildings"

Demonstration Project Brochure

Innovative application
- high performance insulation materials
- solar control system
- heat recovery ventilation
- heat pump system integrated with renewable energies (biomass)
- TABS

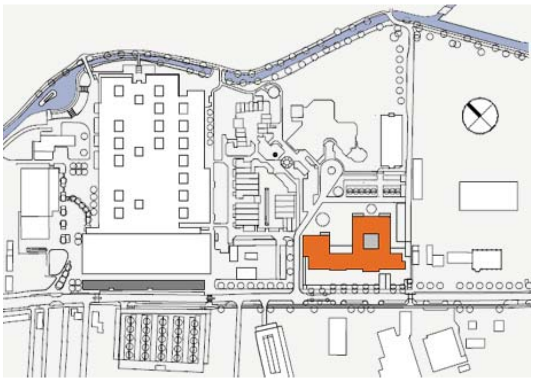
General information:

- Project developers:
  - Planning and site management, buildings and appurtenant structures:

    Projektgemeinschaft Elwert-Stottele-Rädle
    Elwert+Stottele, Ravensburg (Germany)
    Rädle+Textor, Ravensburg (Germany)
  - Technical services, energy concepts, thermal building physics, lighting design, simulation:

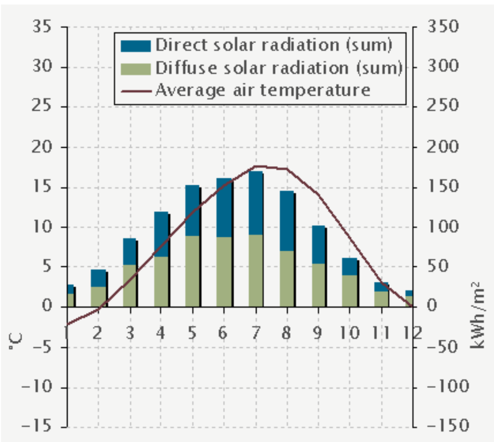
    Ebert Ingenieure, Munich (Germany)
  - Monitoring:

    Hochschule Biberach - Gebäudeklimatik
    Prof. Dr.-Ing. Roland Koenigsdorff &
    Dr.-Ing. Stephan Heinrich
    Karlstr. 11, 88400 Biberach (Germany)
- Location: Leipzigstrasse 25, Biberach a.d. Riß (Germany)
- Project starting date (year): -
- Project status: completed in 2004



School site map [(C] Elwert & Stottele]

Main building (S-W elevation), as seen from Leipziger Strasse [(C] Elwert & Stottele]



Climatic data (monthly values)

Summary of project:

The Gebhard Müller School is a business school located in the Kreis-Berufsschulzentrum Biberach (Biberach District Vocational School Centre) in Baden-Württemberg (Germany), designed as a low-energy building to provide an excellent high comfort educational environment for around 1,650 students and approximately 100 teachers.

This new construction was ended over in September 2004 and represents a good demo of relatively low cost construction despite strict energy standard and sophisticated system technology. . The construction project includes an innovative energy concept with a low heating requirement: the intended target value of 30 kWh/m²a overall heating energy consumption. Energy for heating and cooling is from RES only (groundwater heat pumps with peak heating loads covered by biomass boiler), and the indoor comfort is guaranteed by thermo-active building systems (TABS). Further, sun Shading systems are used to control overheating into classrooms and administrative offices (external shadings) and atrium (internal shadings).

The construction project includes an innovative energy concept with a low heating requirement: for heating and cooling the energy is from RES only (heat pumps with peak heating loads covered by biomass boiler) and the indoor comfort is guaranteed by thermo-active building systems (TABS). Sun shading systems are used to control overheating into classrooms and administrative offices (external shadings) and atrium (internal shadings).

Particularly, the innovative and integrated solutions applied in this demo project contain performance building envelope, particularly transparent façade, and the heating/cooling systems which guarantee indoor comfort, controlling temperature, humidity, air quality, lighting and energy supply costs.

Description of project

- **Climate data (outdoor & indoor):**

o Microclimate: suburban
o Outdoor design temperature: 32°C
o Indoor design temperature: 19°C
o ASHRAE heating/cooling degree days: 3.765 / 832 kd
o Design ventilation rates: Max. 4,5/h
o Design illuminance levels
  - Corridors:100 lux
  - Class rooms: 500 lux

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)

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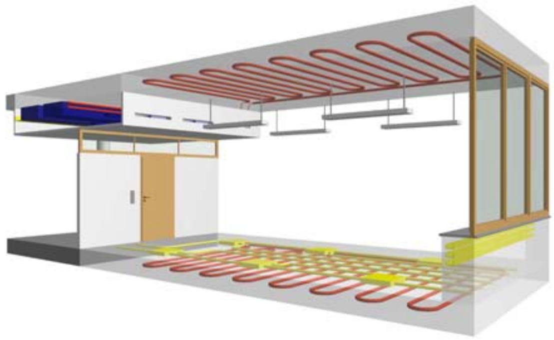
Building characteristics

The three-storey new school building comprises one wing, as a backbone, along the access road. Another underground floor is used as parking. The classrooms are situated in the two cubic building structures, in which the classrooms are situated, that join onto the wing.

The main data related the new building is summarised below:

- Number of floors: 4 (1 below and 3 above ground);
- Usable floor area: 5.542 m^2;
- Gross volume: 59.835 m^3 (of which 16.196 m^3 is underground parking);
- Heated and cooled volume: 43.639 m^3;
- Heated and cooled gross floor area: 11.500 m^2;
- Heated and cooled net floor area: 10.650 m^2;
- Building envelope area: 18.549 m2;
- A/V ratio: 0,31 m^2/m^3;
- Number of occupants: 1.100 -1.200 pupils + 100 teachers.

As common school buildings, in Gebhard Müller School there are different areas with different usage periods, like classrooms, corridors, atria, sport halls. Particularly in the classrooms there is high occupancy densities and consequently high thermal loads and strict air hygiene requirements. Furthermore, adequate lighting conditions, glare protection, sun protection, and indoor acoustics are also important for studying and working in comfort. For these reasons it is necessary to optimise the operation of the complex system technology, taking into consideration the requirements with regard to comfort, flexibility of the indoor areas, and low energy consumption.



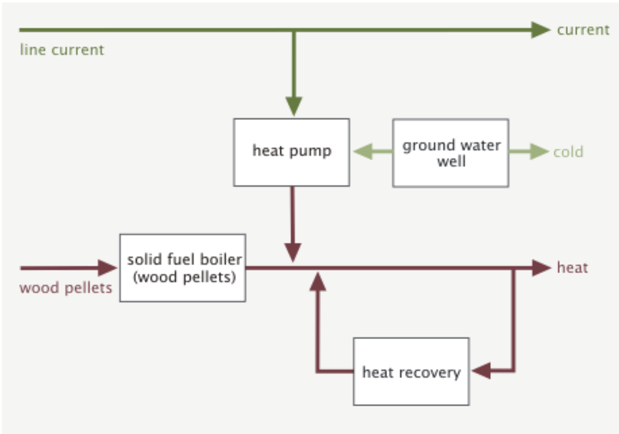
Room Module [(C) Ebert-Ingenieure München]

The main body of the building is made of reinforced concrete. Further, All reinforced concrete ceilings are designed as thermal active building elements with heating and cooling installations.

Technical description

Technical systems

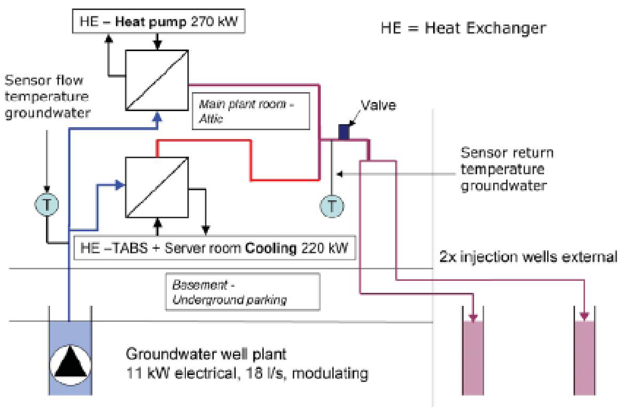
A four meter module was designed, in which all technical components such as ventilation, concrete core temperature control, shading device, artificial light and computer openings are integrated. Each of these can be controlled separately. Thus, within the 4-meter grid the size of the spaces can be adapted without changing the structure or the technical services of the building.



Energy flow diagram [(C) Solarbau:Monitor]

Applications include core activation of the concrete components, the use of groundwater and controlled supply and exhaust air systems with heat recovery. Cooling energy for the component activation and ventilation systems is supplied directly by a groundwater heat exchanger and therefore without additional use of primary energy (except electricity for circulation pumps).

Heating and cooling are supplied by two heat pumps, gradually controlled, which are connected to groundwater through a 16m deep discharge well and two sink-wells. The temperature of the water in the concrete ceilings in winter can be raised up to 28°C by heat pumps. Moreover, a wood pellet boiler is used for peak-shaving (load covering) with a capacity of 120 kW.



Basic scheme of the geothermal groundwater well plant

In summer, cooling is provided using the groundwater through deep wells achieving temperatures of 10°C approx.

The artificial lighting concept is based on light fixtures switchable in rows with direct and indirect illumination

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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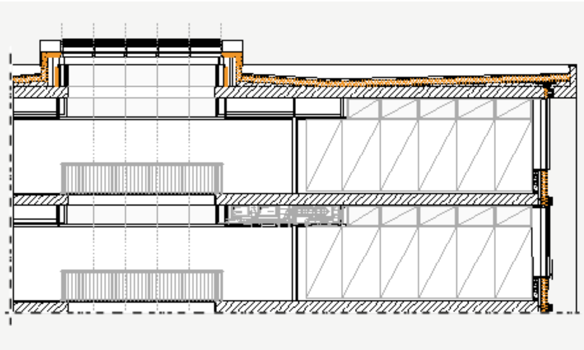
components. Partly operated by the user (switch on) a superior control mechanism is able to adapt the amount of artificial light in relation to the availability of daylight or to switch them off when enough daylight is available. Parallel to the artificial lighting the external louvers are controlled according to the position of the sun. The automatic control system is only operated between school lessons and can be operated any time by the user.

Insulation

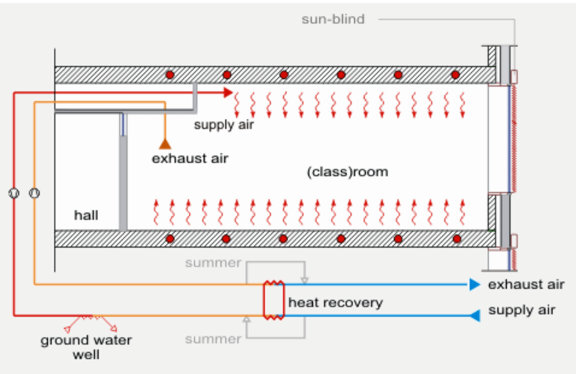
The building volumes differ from their construction; the main body of the building is made of reinforced concrete, the attached classrooms are constructed as reinforced concrete skeleton structures with timber-glass and metal-glass construction.

The ceiling of underground garage is insulated with 18 cm mineral wool. Window area rate: 0,24 m²/m² usable floor area

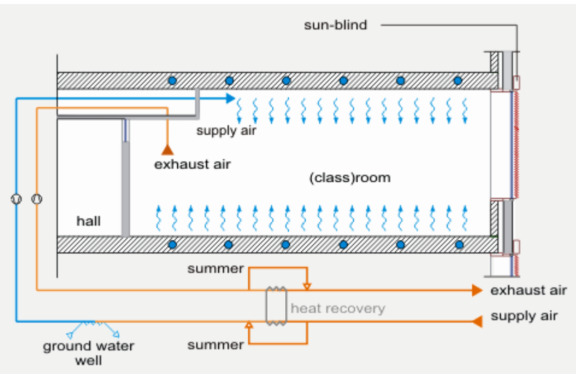
Building element	U (W/m²K)
External wall	0,20
Roof	0,23
Basement ceiling	0,16
Heated basement floor	0,27
Heated basement external wall	0,24
Glazing	1,30
Average U-Value	0,24



Ceiling insulation



Heating concept



Cooling concept with concrete core activation

Ventilation system

The building can be ventilated naturally or mechanically. In each room there is an openable window. It is equipped with contacts, so that the ventilation is switched off when opening the windows.

Heating and cooling systems

The Classrooms are heated with two systems:

- the basic load is covered by means of slow-acting component activation.
- With the mechanical ventilation and exhaust can be reacted to the current situation in individual areas without delay. The air heating and cooling takes place by the means of heat recovery.
- The heating energy for WCs and atrium is supplied by floor heating system.
- Thus in combination with good thermal protections of the building additional heating element at the facades are not necessary.

  necessary, the classrooms are cooled by two systems, which are both coupled to groundwater:
- The supply air is cooled to about 19 - 22°C. Additionally the concrete core activation exhaust cools the rooms.
- The server rooms are cooled over the circulating air coolers which are also connected to groundwater.

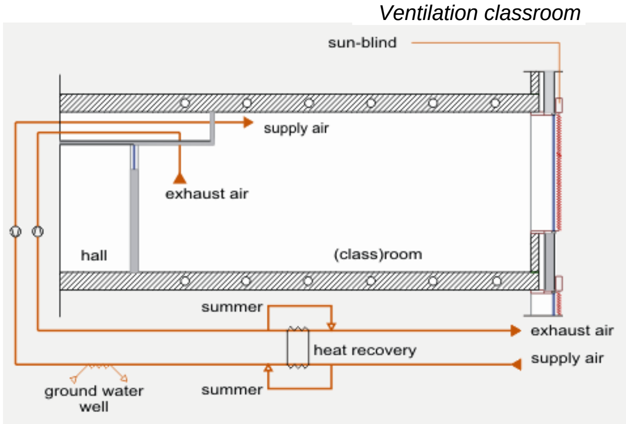
Renewable energy heating & cooling integration

Heating and cooling of the building is made with renewable energies only, except the electricity needed for pumps and ventilation devices:

The ground heat is used for heating and cooling, peak heating load is covered by using wood pellets.

The annual primary energy demand for heating, cooling, ventilation as well as for auxiliary energy is about 70% below the reference value of a conventional school building.

Ventilation classroom



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.

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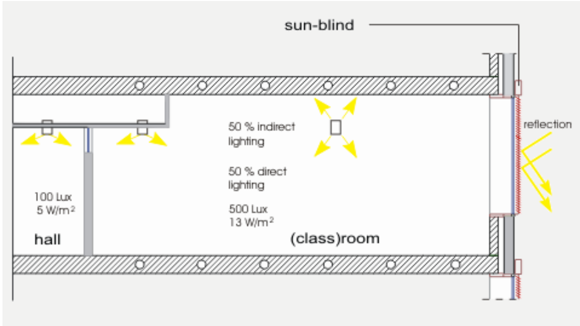
The mechanical ventilation and exhaust throughout the year is realised by three central ventilation devices with heat recovery (rotary generator, efficiency 70%). By means of slit inlets situated on the face of the technique channels in the room, the supply air, tempered at 21 to 23°C, arrives from above into the room. The exhaust air is sucked off underneath the channels.

Light

Daylight: the classrooms and the administration rooms have a central controllable external shading with light-redirecting function. A lamella surface made of aluminum with high reflection degree was selected in order to receive as much light as possible. The underside is designed stone-grey to exclude the glare by too high luminance in window area. The lamella angles are determined with the consideration of azitmuth influence (cut-off) from solar height and sun azimuth (dependent on location), facade orientation and shutter geometry. At the beginning of each lesson, the jalousies are adjusted in such a way that during the entire following lesson the glare is impossible by the sun. Skylights are placed in the partition walls between corridors and classrooms.



Lighting concept

Artificial light: the artificial light concept is based on direct and indirect illumination. There are four suspended lamps per module, which show an indirect portion of 50%.

The artificial light is operated by user. The building control system (GLT) switches the artificial light off depending on existing daylight offer in rows or completely. The user interference over control the GLT in each case for the duration of a lesson.

The supply of public thoroughfares with artificial light is regulated over motion detectors in connection with brightness sensors.

Sun shading device (atrium) [(C) Heide Schuster]

Solar Control

The classrooms and the administration rooms have a central controllable external shading with light-redirecting function. The lamellas are partly or completely closed by an automatic control mechanism, which depends occupancy and on indoor temperature, in order to influence on one hand the day light supply as few as possible and to avoid on the other hand overheating of the classrooms.

Solar glasses with a heat gain coefficient of 50% and g-value of 0,21 are applied for the stairways, the cafeteria and conference area.

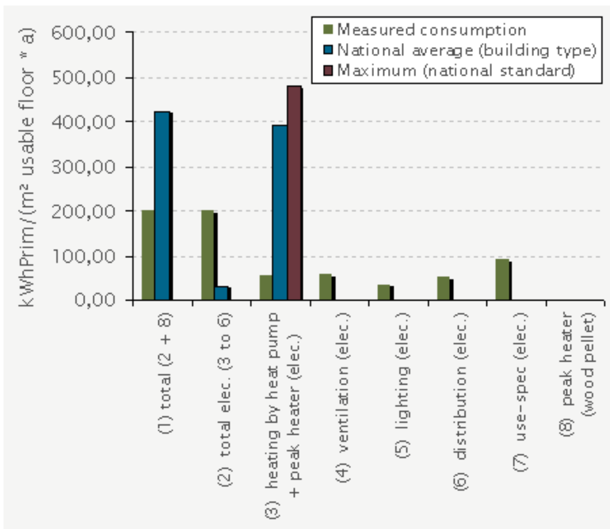
The atrium has an internal shading made of coated fabric. Together with glazing, g-value is 0,19. The heat cushion emerging in summer is ventilated through smoke and heat exhaust flaps.

Energy performance

The energy consumption is expressed based on usable floor area [m²] and shown in the figure in the right sdie. All measured data are taken from German Solarbau: Monitor-Programme (University of Applied Sciences Biberach) and climate adjusted.

In the same figure the national average consumptions are given as well, which are derived from VDI-Code VDI 3807-2. In the Code, building specified consumption (delivered energy) for electricity and heating are given with respect to floor area.

The national standard is "Thermal Insulation Standard 1995 (WSchVO `95). The standard specified a maximum heating energy demand for the heated rooms, which is based on usable floor area. Additionally a standard system-efficiency of 85% has been considered.



Annual primary energy consumption per m² usable floor area

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In detail, the key energy data are summarized in the following table.

Energy indices according to German regulation EnEV (in kWh/m^{2}a)	
Heating energy demand (according to net floor area (without underground car park))	30,00
Measured energy consumption data (in kWh/m^{2}a)	
Thermal heat consumption (in 2005 according to net floor area (without underground car park))	37,00
Total source energy (in 2005 according to net floor area (without underground car park))	116,00
Ventilation	11,20
Heat pump	10,60
Auxiliary power	10,00
Lighting	6,70

Information on project developer

The Owner of the building presented by this demonstration project brochure is the County of Biberach (Germany), whereas the building’s occupant is the Gebhard Müller Schule, which is the District Vocational School Center Biberach.

This demonstration project, which is one of the best example of integration of innovative technical solutions in buildings, is already wide diffused by technical press. Thanks to the European dissemination project “European high quality Low Energy Buildings“, the new the Gebhard Müller Schule is also well worldwide diffused by web.

Further information:

Name of project owner	County Biberach
Address	Leipzigerstrasse 25
City	Biberach a.d. Riß
Postcode	88400
Country	Germany
Contact person	-
Telephone	-
Fax	-
E-mail	wolff(at)elwert-stottele.de
Web-site	www.euleb.info

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The EBC membership will be established through a specific endorsement procedure by the completion of the endorsement questionnaire.
The questionnaire can be downloaded from the project website: http://www.ecobuilding-club.net/downloads/Technology_developers.doc

- If you would like to be included in the project's 'market operator' database, please fill in the form downloadable at: http://www.ecobuilding-club.net/downloads/Market%20operators.doc