Climate-positive zero-energy technical classroom wing

by Barbara Bolsinger / 2021-03-25 17:06:33 / Deutschland / 3035 / DE

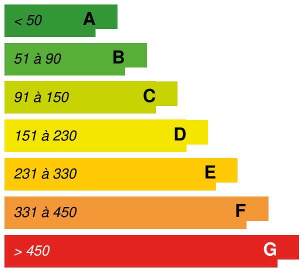
New Construction

Primary energy need :

47 kWhpe/m².year

(Calculation method : Other)

ENERGY CONSUMPTION



Building Type : School, college, university
Construction Year : 2019
Delivery year : 2019
Address 1 - street : Rombacher Str. 26/2 73430 AALEN, Deutschland
Climate zone : [Cfb] Marine Mild Winter, warm summer, no dry season.

Net Floor Area : 1 100 m²
Construction/refurbishment cost : 3 892 436 €
Cost/m2 : 3538.58 €/m²

General information

Building with environmental energy: Active building instead of passive house

The specialist wing is a zero-energy building that generates at least as much energy locally and regeneratively over the year as it consumes, based on a primary energy balance. The balance includes the building's operation for heating, ventilation and lighting and the energy quantities for user electricity. A special feature is the holistic consideration of the topic of insulation. Detailed simulations have shown that the energy saving potential of additional insulation is only small when pupils open and close the doors countless times a day, while the additional costs are very high. Therefore, a good insulation standard was achieved rather than passive house quality. The building is an active house that uses passive technology to make maximum use of the environmental energies of light, thermal energy and geothermal energy and is thus a conscious counter-design to the ongoing mechanisation of buildings. The building is climate-positive in operation, saving approximately 5 tonnes of CO_2 per year.

See more details about this project

https://youtu.be/OymOH_FIVJc

Data reliability

3rd part certified

Photo credit

Photographer: Valentin Schmied
Sketches: Transsolar Klimaengineering

Stakeholders

Contractor

Name : Liebel/Architekten BDA
Contact : Bernd Liebel, bernd.liebel@liebelarchitekten.de, 73430 Aalen
http://www.liebelarchitekten.de

Construction Manager

Name : Liebel/Architekten BDA
http://www.liebelarchitekten.de

Stakeholders

Function : Contractor
Stadt Aalen

https://www.aalen.de

Function : Others
Transsolar KlimaEngineering

Markus Krauss, Krauss@Transsolar.com, München

https://transsolar.com/de

Function : Structures calculist
Ohligschläger, Ribarek, Roll , Ingenieurbüro für Tragwerksplanung, Aalen

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Function : Others
Jelli & Burkhard GmbH & Co.KG, Planungsgesellschaft für Technische Gebäudeausrüstung, Giengen

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Function : Others
Dr. Ing. Hottmann - Ingenieurbüro für Tragwerksplanung, Schwäbisch Gmünd

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Function : Others
IWB Aalen GmbH, Aalen

Function : Others
PBS Ingenieurgesellschaft mbH, Aalen

Contracting method

Other methods

Owner approach of sustainability

Conscious counter design to the ongoing mechanisation of buildings

Schools account for a high percentage of the city's building space, and their ongoing operation is a significant item in the city's budget. With appropriate planning, resources and operating costs can be saved here. The aim of the concept was therefore to make maximum use of cost-neutral environmental energy. A comparative cost calculation between the passive house (with the corresponding requirements for insulation thickness) and the active house (with a good insulation standard, but still not a passive house insulation standard) resulted in a price advantage of approx. 25,000 euros for the active house, which thus represented economically better, more economical solution both in terms of investment (due to lower investment costs) and in terms of maintenance (zero-energy building taking into account the total energy consumption, incl. user electricity with active energy generation instead of the passive house, which continues to consume energy, especially user electricity).

- 100 % coverage of energy consumption by PV system

- Exhaust ventilation with extremely low air velocities and no exhaust air network: approx. 80% savings compared to conventional ventilation.
- Increase of the daylight quotient from 2.9 to 4.3 through skylights, i.e. approx. 50% more daylight, i.e. approx. 50% saving of artificial light.
- the saving in thermal energy for heating the outside air with the help of the earth duct is 17 % or 1.1 MWh/ a.
- preheating of the supply air in winter by approx. 5 K through the 45 m long earth duct and cooling in summer by 5 k.
- Highly efficient WRG: efficiency 75%.
- Cooling is exclusively passive by utilising the thermal storage mass. This is cooled at night by effective natural night cross-ventilation using natural thermals.

Perfect interaction between architects and air-conditioning engineers

Liebel/Architekten and Transsolar's air-conditioning engineers have been working together on a wide range of projects for over 10 years. These include a bank building, a multifunctional school canteen, a company building and - currently in planning - a zero-energy children's house. The offices pursue the same goals in planning and project development. On the one hand, a high architectural and urban development quality of the new building that fulfils the complex requirement profile and focuses on the user of the building. On the other hand, an integral climate concept that draws on natural resources and principles and thus minimises the technical effort.

Architectural description

The specialist wing for chemistry and biology burrows into the ground so as not to obscure the view of the listed school. By incorporating the existing room geometries, a joint school ensemble is created from the individual building complexes. The energy-saving building design, which is tailor-made for the site, increases the energy quality of the building with its resource-efficient and compact construction and thus reduces energy consumption. The basic structure is a timber-concrete hybrid building with a balanced distribution between environmentally friendly timber elements and solid and thus heat- and cold-buffering building components. The north-facing shed roof was realised because the daylight yield is highest with this roof form. "Low Tech - High Comfort" was a focus of this project, because a high level of natural visual and thermal comfort forms the basis for efficient learning and has a demonstrable influence on educational success.

Building users opinion

School management and subject teachers were involved from the start of planning so that didactic wishes could be taken into account accordingly. Before the start of operation, the ventilation and energy concept and the correct user behaviour were explained, as only enlightened users can use the building in an energy-saving way. The feedback is very positive and the concept is supported by the teachers. Because they are convinced of it and because it has proven itself in everyday life.

Energy

Energy consumption

Primary energy need : 47,00 kWhpe/m^2.year

Primary energy need for standard building : 81,00 kWhpe/m^2.year

Calculation method : Other

Final Energy : 62,00 kWhfe/m^2.year

Breakdown for energy consumption :
New calculation formula: 1+1=1
The gas-fired block heating system of the old building is used for heating. The load reserves are sufficient to cover the low heating requirements of the new building, so that a new heating system could be dispensed with. A PV system on the roof of the new building provides electricity (parallel to the power grid). This feeds the surplus electricity in the summer half-year into the local, newly constructed electricity grid of the school complex, so that both the new and old buildings benefit from each other. A special energy source is the energy from the ground, which is used via the underground duct for pre-cooling in summer and for preheating the supply air in winter.

More information :
The photovoltaic system covers 100% of the primary energy requirement.
Energy consumption electricity: 45kWh / m2a
Energy consumption heating: 43 kWh / m2a

Envelope performance

Indicator : EN 13829 - q50 » (en m3/h.m3)

Renewables & systems

Systems

Heating system :

- Combined Heat and Power
- Others

Hot water system :

- Individual electric boiler

Cooling system :

- Others

Ventilation system :

- Natural ventilation
- Nocturnal Over ventilation

Renewable systems :

- Solar photovoltaic

Renewable energy production : 100,00 %

The new building is a zero-energy building. Passive measures are the roof optimisation for daylight and night ventilation and the earth duct, which uses environmental energy to precondition the outside air. The active element is the PV system on the roof The building is cooled exclusively through the heat storage of the massive building components. Motorised window sashes provide effective night ventilation as cross-ventilation, which is driven by natural thermals due to the shape of the shed roof. The hybrid ventilation system is a combination of window ventilation and thrust ventilation. The supply air is pushed slowly (due to large ventilation cross-sections) into the classrooms via a 45m-long underground duct by an energy-efficient, slowly rotating fan. From there, free overflow takes place by means of sound-insulated overflow elements with minimal resistance into the foyer. Heat is extracted from the foyer's exhaust air by means of a heat exchanger and returned to the supply air. The duct has a purely passive effect. It pre-cools the fresh air in summer and preheats it in winter. Even at low outside temperatures, this ensures air quality without draughts.

Solutions enhancing nature free gains :

Geothermal energy, solar energy, maximum utilization of daylight, utilization of natural thermals, natural reduction of the summer heat input through shading by deciduous trees

Smart Building

BMS :

For quality assurance purposes, the building is equipped with a measurement and control system that records faults and maintenance impulses across the individual components of ventilation, heating, backwater protection, heat exchangers, fire dampers, etc. and forwards them automatically to the responsible departments. In the course of commissioning, the individual components, such as the ventilation volume, were first calibrated, the heat exchanger was adjusted, etc. The calibration was carried out according to a protocol. The adjustment was carried out according to the protocol. After the adjustment of the individual components, the interaction of the components was checked and then transferred to the MSR and controlled. In the course of monitoring, the individual components are currently still being monitored and optimised. The goal is to optimise the energy consumption at the real object under real conditions.

Environment

Life Cycle Analysis

Eco-design material :

In general, adequate materials for school construction were sought from the very beginning. This refers to durability, easy exchangeability of surfaces for renovations and retrofitting possibilities for IT, e.g. for system partitions. Thanks to the box construction method, more than 50% of material is saved compared to solid wood constructions with the same static efficiency. The wood comes exclusively from domestic, sustainably managed forests. The LIGNATUR elements are PEFC-certified and suitable for Minergie-ECO buildings. During construction, the building site was closely monitored to ensure that the planning matched the execution. The materials used were planned, specified in the tender and monitored during installation. In the course of the documentation of the manufacturers, the plans/data/data sheets were handed over to the building owner.

Comfort

Health & comfort :

"Low Tech - High Comfort" is a focus of this project. The high level of natural, visual and thermal comfort, good room acoustics and the careful selection of surface materials create a school building with a high quality of stay. The resulting sense of well-being for the users increases building acceptance, reduces vandalism and creates identity and identification. In cooperation with Aalen University (Chair of Technical Writing), an app is currently being developed as part of a student research project to communicate the innovative energy concept and sustainable construction method to current and future users. In this way, the educational mission of the school will be expanded beyond the teaching content and possibly arouse interest in the topic and the job description.

Daylight factor : Erhöhung des Tageslichtquotient von 2,9 auf 4,3 durch Oberlichter, d.h. ca. 50 % mehr Tageslicht, d.h. ca. 50 % Einsparung des Kunstlichts.

Costs

Urban environment

The new campus created by incorporating the existing spatial axes is used intensively as a neighbourhood square outside school hours. For children, young people and students in particular, it can be used in a variety of ways, with a sports field, climbing frame and skateboarding facilities. The large canopy creates additional opportunities to linger.

Building Environnemental Quality

Building Environmental Quality

- consultation - cooperation
- comfort (visual, olfactive, thermal)
- energy efficiency
- renewable energies
- integration in the land
- products and materials

Contest

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