# Plus Energy Primary School and Gymnasium, Hohen Neuendorf, Germany

**Ingo Lütkemeyer*, Hans-Martin Schmid, Gustav Hillmann**

IBUS Architekten und Ingenieure, Caspar-Theyß-Str. 14a, 14193 Berlin, Germany

*info@ibus-architekten.de

**Abstract**

This project will show that it is possible to realize a Plus Energy Primary School without increased costs in comparison to a "normal" new school building. The basic approach is to optimise the architectural design in order to permit a lean building with a simple, easy controllable and low maintenance engineering system. A sustainable, ecological concept can be implemented by using renewable sources. A photovoltaic plant will compensate the energy demand by feeding into the local grid.

With the financial support of the Bundesministerium für Wirtschaft (programme: EnOB), different innovative components and products can be applied and monitored. The results of the different research areas will be documented and can be used for future projects.

Keywords: plus energy building, school, renewable energies, research/demonstration project

## 1. Challenge and concepts

The cooperation between architects, engineers and other professionals is essential for realizing ambitious projects like the one presented here. The basic approach of this project is the integration of architectural and technical issues to unite school adequate and functional architecture with low costs, energy efficiency, ecology and sustainability. Goal is to realize a Plus Energy School keeping the complexity of the engineering systems as low as possible and at the same time reaching a high comfort indoor climate. For this project the term "Plus Energy Building" refers to a building that produces more primary energy than it consumes. The electricity production of photovoltaic panels and a combined heat and power plant compensates the primary energy demand of the school.

The main features of the integrated building concept are:

- Passive house standard of the building envelope
- Use of passive solar energy
- Improved thermal comfort in summer
- Night ventilation, use of thermal mass for heat storage
- Hybrid ventilation strategy
- Optimisation of daylight and artificial lighting
- Use of renewable energy sources
  - Wood pellets for heating
  - Photovoltaic plant for power generation,
  - Combined heat and power generation with a wood pellets driven Stirling motor.

- Integration of new and innovative building components

This includes different types of innovative glazings, LED lights, filters and control for the ventilation system and a visualisation display. A monitoring of the whole engineering system and energy performance of the school is planned. During the monitoring phase an optimisation and adjusting of the engineering system will be realized. The gained knowledge can be used for future projects.

### 2.1 Architectural concept

The two-floor school building is located in the city of Hohen Neuendorf north of Berlin. The building has a gross floor area of 7400 $m^2$ and consists of three wings for the classrooms, specially equipped rooms for teaching, a small library, a kitchen, a cafeteria, and an assembly hall. The north part of the building is a gymnasium with service rooms.


Fig. 1: Site plan.

Most classrooms are oriented to the south and equipped with very effective solar shading devices.

Fig. 2: Rendering of the south facade.

### 2.2 Building envelope

The following table shows the different constructions and their U-values which will be used for the school's building envelope. The U-values equate the Passive House Standard.

Table 1: U-Values of the school

| Construction | U-Value [W/(m²K)] | Materials |
|---|---|---|
| Exterior wall Type 1 | 0,15 | Armoured concrete with facing bricks, thermal insulation of mineral wool 032 |
| Exterior wall Type 2 | 0,13 | Hollow concrete blocks with facing bricks, thermal insulation of mineral wool 032 |
| Windows | < 0,8 | With frame of wood and aluminium |
| Roof | 0,11 | Ferro concrete, thermal insulation of polystyrene particles and green roof plants |
| Floor | 0,1 | Ferro concrete, thermal perimeter insulation of expanded polystyrene (EPS) |

### 2.3 Functional und technical Integration

- Flexibility of the home area

The technical concept bases on the functional concept and is developed for a so called home area for each class. Each home area includes the classroom, a smaller room for different purposes, a wardrobe, bathrooms and a corridor extension.

The next figures show different possibilities to use the classrooms: the "traditional" classroom with an additional relax zone, two arrangements for working in small groups (one using the corridor) and another arrangement for working on projects in larger groups.

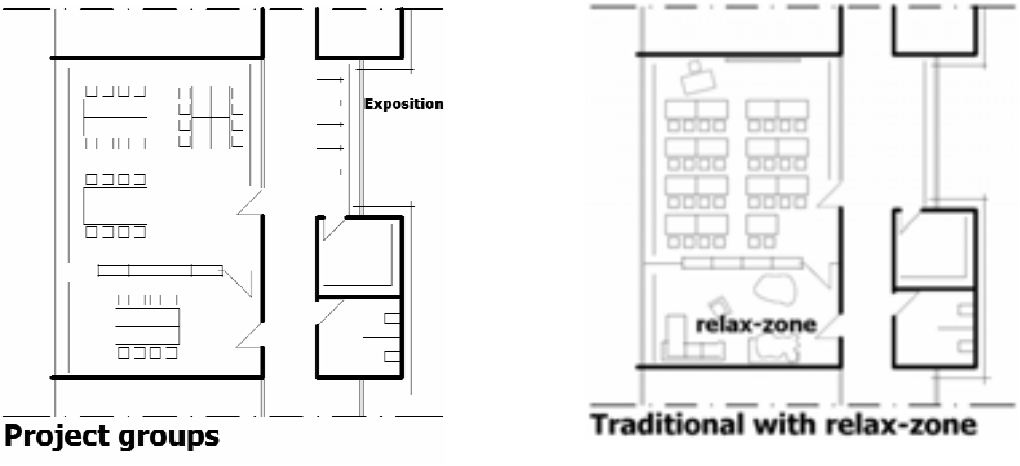


Fig. 3: Different options for using the classrooms (part 1).

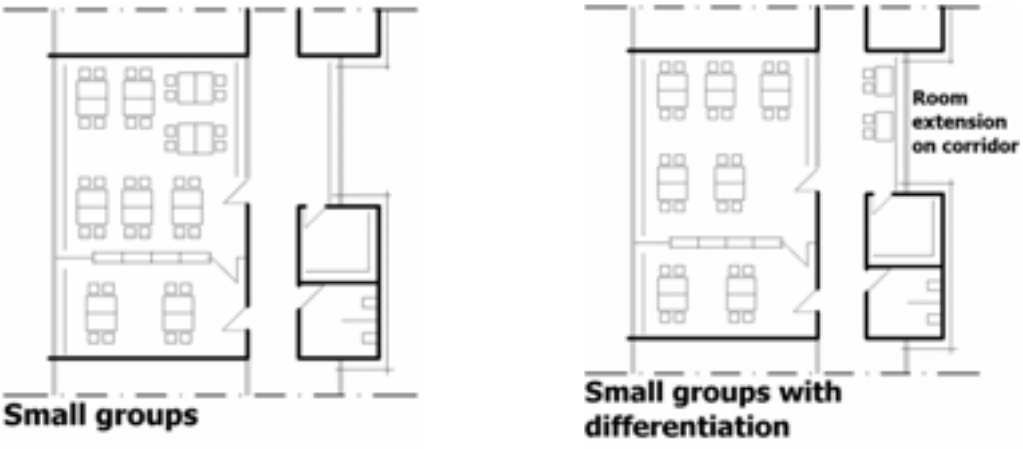


Fig. 4: Different options for using the classrooms (part 2).

- Hybrid ventilation concept

Measurements in schools show that in most cases there is a lack of fresh air in classrooms. The windows are not opened sufficiently and contamination of the air and its $CO_2$ concentration increase with every lesson while the pupils' concentration decreases. To provide a good air quality the ventilation strategy bases on a hybrid concept.

A mechanical ventilation system with effective heat recovery provides fresh air for the classrooms, but it is not planned to cover the complete fresh air demand. During the breaks between lessons, windows can and must be opened from time to time. As experience shows in schools often the windows are not opened adequate, so electrical window openers will be installed.

These windows with electrical driven openers will also be used for ventilation of the classrooms during the nights in summer.

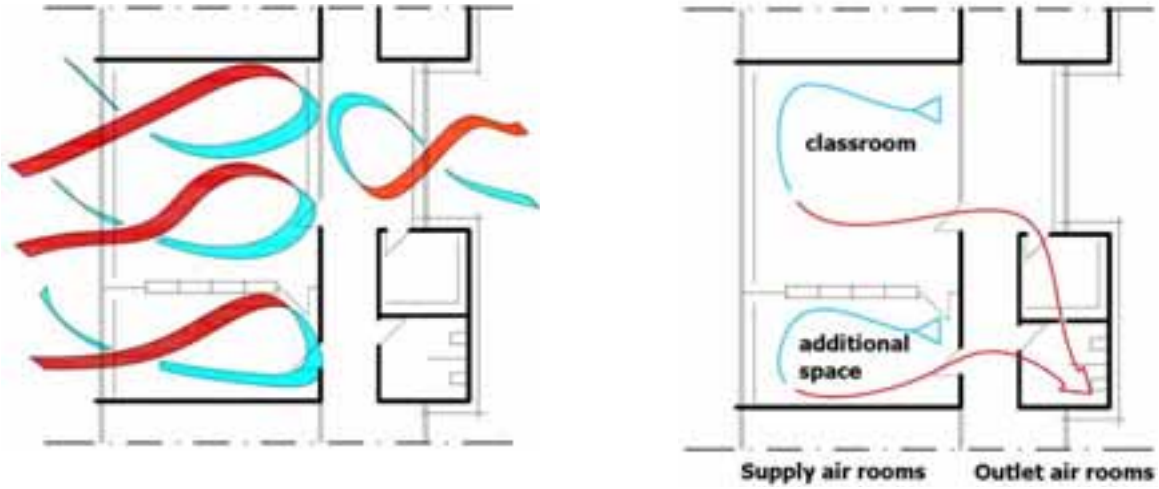


Fig. 5: The two ventilation concepts: natural (left) and mechanical ventilation (right).

- Daylighting and lighting control

In schools the illumination of working areas is essential for the learning process of pupils. For the energy performance of the building it is important to minimise the electricity demand, so it is advantageous to utilize as much natural light as possible. A daylight simulation of the home area, the classrooms and the gymnasium was made to optimise window sizes. The classrooms are daylit towards windows which are in two opposite walls (see Fig. 6).

An automatic control of the artificial lighting and light reflecting elements are designated. Depending on specific room requirements different glazings and shading devices will be used, e.g. nano gel glazing, micro structured anti-sun glasses, light reflecting and electro chrome glazings.

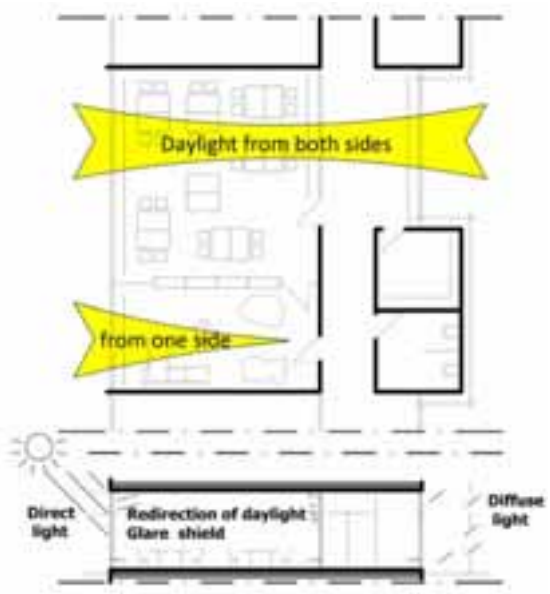


Fig. 6: Scheme of daylight situation in classrooms.

### 2.4 Plus Energy Concept

A very good insulation of the building is the indispensable base for minimised energy losses. The remaining energy demand for heating will be realised with a pellet driven boiler and a combined heat and power plant (CHP) with a Stirling motor, also wood pellet driven. Realizing the heat supply with pellet based systems makes the heat generation $CO_2$ neutral.

The power generation with the CHP is complemented with the installation of photovoltaic panels on the south orientated parts of the roof. In total the generated power based on renewable energies compensates the required none renewable energy during the operation of the school building.

The following figure shows the whole energy supply system of the school to sum up the precedent descriptions.

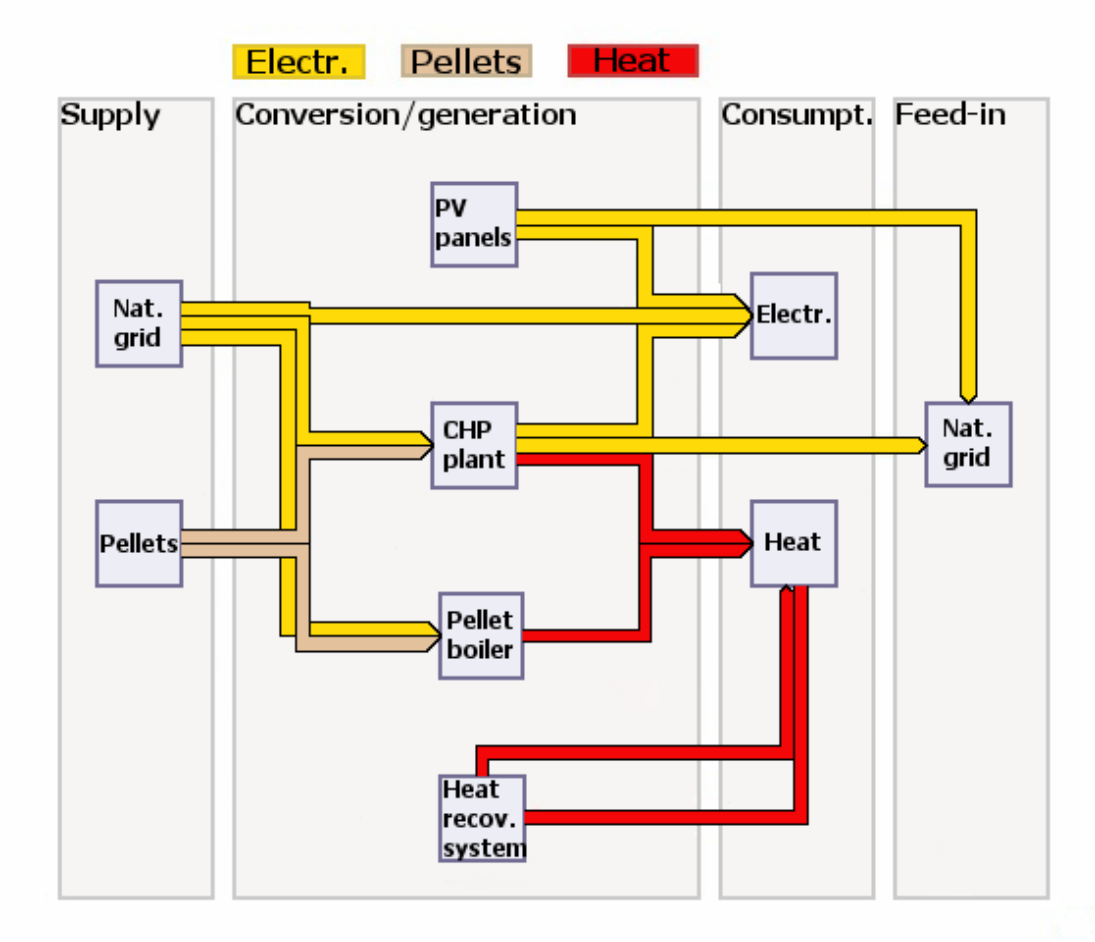


Fig. 7: Scheme of energy supply.

### 2.5 Sustainability

The idea of an ecological and sustainable school is represented in the whole plus energy concept. Fuel for heating and partly generating electricity will be the renewable resource wood, in form of pellets. A part of the roof was planned especially for the power generation with photovoltaic panels; it is south

orientated with a 30 degree slope. Using solar energy for power generation forms also part of the ecological and sustainable concept and is essential for reaching the goal of a Plus Energy Building. The electricity of the PV- and combined heat and power plant compensates the energy demand by feeding into the local grid. The power generation (heat and electricity) of the school is $CO_2$ neutral. Green roofs decrease the impact on nature which results from covering “green areas” with buildings.

## 3. State of Art/Outlook

The building is under construction. Completion will be at the end of 2010. The monitoring will start in 2011.

## 4. Design and research team

Table 2: Design and research team

| | | |
|---|---|---|
| Client | City of Hohen Neuendorf, Germany | |
| Architectural Design, Daylighting Concept, Overall Coordination | IBUS Architekten und Ingenieure GbR | Prof. Ingo Lütkemeyer, Hans-Martin Schmid, Dr. Gustav Hillmann |
| Building Services, HVAC, Energy Concept | BLS Energieplan GmbH | Jens Krause,Marko Brandes |
| Consultancy/ Accompanying Research<br>• Life-Cycle-Analysis<br>• Acoustics<br>• Monitoring Concept | Sol◦id◦ar Planungswerkstatt (research management)<br>• Ascona König-Jama GbR<br>• Büro Dr. Hennings<br>• Ingenieurbüro SICK Berlin | Günter Löhnert<br><br>• Holger König<br>• Dr. Detlef Hennings<br>• Prof. Dr. Friedrich Sick |
| Monitoring | HTW – Hochschule für Technik und Wirtschaft (University of Applied Sciences) | Prof. Dr. Friedrich Sick |

This project is financially supported by a governmental project (EnOB – Energy Optimised Building).

## 5. More Information

In order to obtain more information and to follow the building process visit:

http://www.eneff-schule.de/index.php/Demonstrationsobjekte/Plusenergieschulen/low-tech-und-low-cost-plusenergie-grundschule-hohen-neuendor.html or

http://www.enob.info/de/neubau/projekt/details/plus-energie-grundschule-in-hohen-neuendorf/

Also monitoring results will be published on these websites. Unfortunately these websites are only available in German at this time.

## References

[1] IBUS: Neubau einer Grundschule und Sporthalle; Goethestraße, Hohen Neuendorf; Entwurfsplanung, Erläuterungen; Februar 2009.

[2] BLS-Energieplan: Neubau einer Grundschule und Sporthalle; Goethestraße, Hohen Neuendorf; Entwurf, Technische Gebäudeausrüstung; Juni 2009.

[3] IBUS: „Low-Tech“ und „Low Cost“ Plusenergie – Grundschule Hohen Neuendorf, Brandenburg; Februar 2009.

[4] www.eneff-schule.de

[5] www.enob.info

## Figures