

## **SCHOOL OF THE FUTURE – TOWARDS ZERO EMISSION WITH HIGH PERFORMANCE INDOOR ENVIRONMENT**

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### **Summary**

The aim of the “School of the Future” project ([www.school-of-the-future.eu](http://www.school-of-the-future.eu)), which receives funding within the EU’s 7<sup>th</sup> Framework Programme, is to design, demonstrate, evaluate and communicate shining examples of how to reach the future high-performance building level. School buildings and their primary users, namely pupils – the next generation – are in the focus of the project. Both, the energy and indoor environment performance of 4 demonstration buildings in 4 European countries and climates is being greatly improved due to holistic retrofits of the building envelope, the service systems, the integration of renewables and building management systems. The results and the accompanying research and dissemination efforts to support other actors dealing with building retrofits is leading to a multiplied impact on other schools and on the residential sector, since the pupils will act as communicators to their families. The user behaviour and the awareness of energy efficiency and indoor environment are being improved due to tailored training sessions.

Nearly zero emission or nearly zero energy buildings are a main goal in various country roadmaps for 2020. The demonstration buildings of this project may not completely reach this level, though, as the aim of the call is cost efficiency and multiplication potential. The retrofit concepts however, result in buildings with far lower energy consumption than in regular retrofits with high indoor environment quality – thus leading the way towards zero emission. They can be considered as schools of the future. Results from national examples of zero emission schools complete the information used for developing the deliverables such as guidelines, information tools, publications and a community at the EU BUILD UP portal.

The project is based on a close connection between demonstration, research and industry which is being represented by the “Design Advice and Evaluation Group”. This group of research and industry partners meets at every demonstration building site twice in order to give advice to the local planning group such as to inform them on suitable up-to-date technologies.

**Keywords:** school, retrofit, EU FP7, energy efficiency, renewables, indoor comfort, demonstration building, guidelines, training, community, BUILD UP, technology screening

## **1 Concept of the project**

The concept of the School of the Future project consists of 3 main parts:

1. Design, demonstration and evaluation of highly energy efficient retrofitting of schools in 4 different European countries with differing climates
2. Development of guidelines and tools – building upon existing knowledge and tools – applicable throughout the EU countries
3. Dissemination of results, guidelines and tools – also including training activities

The design, demonstration and evaluation of the school retrofits are tackling two major challenges at the same time: energy saving and indoor environment quality.

The development of guidelines and tools builds upon existing knowledge and further develops already available instruments in order to cover both qualities, the energy efficiency and the indoor environment. The guidelines and tools will be applicable throughout the EU countries. The guidelines address four different subjects: building construction elements, building service systems, improved indoor environment quality and solution sets for zero emission schools.

Two types of simple to use tools are being further developed: one which focuses on the presentation of information such as case studies and retrofit technologies, that will also contain the guidelines and a benchmark system for average and best practice energy performance data, and one that allows an energy performance assessment of school buildings with and without retrofit measures. The main target groups of the information tool are public authorities and other types of planners. The calculation tool enables different user groups including students to perform a simple assessment of the energy quality of school buildings.

The project results and the deliverables are available on the project website and on the EU platform for energy efficiency in buildings “BUILD UP” Here the project submits its results and deliverables as news, publications, tools and cases. A community “School of the Future” was started that enables discussions and gathers targeted information on energy efficient school buildings with high indoor comfort.

The training activities support the energy saving retrofits by providing the building users (students, teachers/office workers and care-takers) with information on how to correctly use the building and the integrated technologies so that further energy use reduction can be achieved.

## **2 Objectives of the project**

The objectives of the School of the Future project can be summarised as follows:

- Increasing people's awareness to save energy by exemplary realisations of highly energy efficient retrofit projects of school buildings that will lead the way to carbon free approaches with at the same time high performance indoor environment. The success of the retrofits shall be measured by the realisation of the following goals:
  - Reduction of the total energy use > factor 3, verified through monitoring
  - Reduction of the heating energy use > 75 %, verified through monitoring
  - Improvement of the indoor environment quality (air, daylight, acoustic, thermal comfort) with impact on the pupils' performance to be analysed by short-term measurements and questionnaires

- Demonstration that such big energy savings can be achieved with limited additional costs (< 100 €/m<sup>2</sup>). This will motivate other actors in the sector to multiply the concepts. Schools of the future can be realised already today.
- Reducing reservations against innovative energy saving retrofit concepts in public building administrations by provision of reliable information, energy saving potentials and costs.
- Development of national and European benchmarking systems including estimation of potentials for innovative, cost-efficient energy retrofit strategies

### 3 Main Results so far

#### 3.1 Development of the energy efficient retrofit concepts for the 4 demonstration school buildings

The development of the retrofit concepts for the 4 demonstration school buildings in Stuttgart (Germany), Cesena (Italy), Ballerup (Denmark) and Drammen (Norway) followed the energy efficiency goals listed in chapter 2. The work of the local integrated planning team at each city was mirrored by the so-called Design Advice and Evaluation Group that is comprised of all industry and research partners of the project. In two meetings at each school building the energy concept was reviewed and proposals for further improvement and for innovative technologies have been made. These advices have been evaluated in terms of applicability by the local planning group and a final retrofit concept has been designed.



*Fig. 1 Photos of the 4 school buildings retrofitted in the School of the Future project.  
From left to right: Solitude Gymnasium in Stuttgart, Tito Maccio Plauto Middle School in Cesena, Hedegårdsskolen in Ballerup, Brandengen skole in Drammen.*

Highlights in the 4 energy efficient retrofit projects are:

- The **Solitude Gymnasium in Stuttgart**, Germany strongly improved the thermal quality of the building envelope due to insulation measures and window replacement (triple-glazing). There will be an automatically controlled natural ventilation system based on CO<sub>2</sub> sensors. The heating for all building units will be provided by a cogeneration unit. Together with the photovoltaic system on the roof electricity will be generated by the school building which will after the renovation be connected to the city's long-term monitoring and control system.
- At the **Tito Maccio Plauto Middle School in Cesena**, Italy the renovation measures include the insulation of the exterior walls, the cellar ceiling and the attic which eliminates various prior existing thermal bridges. Modulating boilers with advanced control system and a sub-division of the heating circuit will ensure energy efficiency of the heating system. The adaptation of the heating and the mechanical ventilation

system operation to the actual use of the rooms will further reduce the heating use. A photovoltaic system on the roof will decrease the electricity use.

- At **Hedegårdsskolen in Ballerup**, Denmark it was decided to demolish the external brick wall layer and to add insulation and a light façade closing instead. Photovoltaic on the roof and different lighting systems that shall be tested in classrooms are also part of the renovation concept.
- The **Brandengen skole in Drammen**, Norway, a listed building, was allowed to replace the windows with triple-glazed windows after several meetings with the antiquarian authorities. The walls between the mansard windows and the floor of the attic were insulated. Heat is provided by a geothermal heat pump and the existing ventilation ducts were insulated.

### **3.2 Database of publications and projects about energy efficiency and indoor environment quality**

The database on the project website includes a bibliography of publications about greenhouse gas emissions related to energy consumption, effects of indoor climate on health and performance, and relations between energy efficiency and indoor environments. Furthermore the database includes information about international projects relevant for school building retrofitting, and programs and centres in the participating countries.

### **3.3 Guideline on the assessment of the indoor environment including an occupant questionnaire for complaint discovery and measurement instructions**

As basis for the indoor comfort survey in the 4 school buildings before and after the renovation, the Design Advice and Evaluation Group has developed a user questionnaire covering various indoor comfort areas (IAQ, lighting, noise, temperature, etc.). The report, which is applicable to other projects as well, includes also background information for measuring indoor comfort.

### **3.4 Screening of possible retrofit technologies**

The screening process results in an overview on the available building and system retrofit technologies for energy efficient school buildings including their impact on the energy performance and indoor environment quality as knowledge base for all designers and planners of school buildings.

### **3.5 Community “School of the Future” on BUILD UP**

The project has launched an information and discussion platform on EU’s portal for energy efficiency in buildings BUILD UP (<http://www.buildup.eu/communities/schoolfuture>). Not only the results and news of the project are presented there but also information on other national and international projects dealing with energy efficient school buildings.

## **4 Conclusions**

The conference presentation will focus on the retrofit of the demonstration buildings and the results of the technology screening process.