Sustainable school building renovation promoting timber prefabrication, indoor environment quality and active use of renewables

RENEW SCHOOL

Co-funded by the Intelligent Energy Europe Programme of the European Union

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The aim of the project

... promote and increase high-energy performance and prefabricated timber-based renovation of school buildings in Europe!

http://www.renew-school.eu/en/home/
Objectives

- Increase the number of nZEB school buildings
- Assist the target groups with tools and concepts
- Force the know-how exchange of multipliable renovation methods, initiate trainings for SME
- Convince the users by awareness projects
The integrated and multifunctional solutions are based on:
• Timber prefabrication (with integrated facilities)
• Ventilation (indoor air quality)
• Intelligent daylight / shading (control)
• Renewables (on-site or nearby)
European Cooperation

- 9 countries
- 13 partner - organisations

<table>
<thead>
<tr>
<th>Partner organisation</th>
<th>Consortium</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEE - Institute for Sustainable Technologies, AT</td>
<td></td>
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<tr>
<td>Passiefhuis-Platform vzw BE</td>
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<tr>
<td>Holzcluster Steiermark GmbH, AT</td>
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<tr>
<td>Trentino Technological Cluster, IT</td>
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<td>Wood Industry Cluster, SI</td>
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<td>Technical University of Denmark, DK</td>
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<td>Asplan Viak AS, NO</td>
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<td>National Energy Conservation Agency, PL</td>
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<td>Chalmers tekniska högskola, SE</td>
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<tr>
<td>Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung</td>
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<td>Informest – Centro Di Servizi E Documentazione Per La Cooperazione</td>
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<tr>
<td>Autonoom Gemeentebedrijf Stedelijk Onderwijs Antwerpen, BE</td>
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<td>Politecnico di Milano, Dipartimento di Energia, IT</td>
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Contact Co-ordinator: Armin Knotzer, AEE INTEC – a.knotzer@aeec.at, www.renew-school.eu
School buildings from the 1950s to 1980s with:

- High Energy Consumption
- Poor Indoor Air and Light Quality
- Fossil Fuels

- A high need of school renovations all over Europe
- A big typological potential for the use of prefabricated elements
Main impact

• 24 visits to 18 visualized frontrunner buildings
• 20 school buildings renovated to nZEB initiated
• Web-decision tools (cooperation models, technical solutions) and website as exchange platform
• 16 technical workshops on cooperation models and on technological options, 8 technology talks
• Around 5,000 pupils in awareness raising projects
• Trainings for 400 employees of at least 100 SME
• 10,000 interested persons of the target group attracted by material like video
• Survey
Background

Demo-school renovations

Source: arch+more, AEE INTEC
Background

Pre-fabrication

Improvement of the building’s envelope by coating it with insulated prefabricated timber modules including wooden frame windows, solar shading and ventilation components. ... quickly done!
High performance renovation of residential building
1. Residential area Dieselweg 4, Graz, A

Key technologies
• Solar façade
• Pre-fabrication of facade modules
• Energy concept based on renewable energy sources (mainly solar thermal energy)
• New heating- and DHW supply system installed between the façade and existing wall
• Decentralized ventilation systems with heat recovery
• Control and remote maintenance via internet
Renovation concept - Façade solutions

Exemplary floor plan of renovated building – showing new thermal envelope, integrated balconies and new lift [Source: Hohensinn ZT GmbH]

Cross section – new thermal envelope

Layer composition of basic façade module

<table>
<thead>
<tr>
<th>Layer</th>
<th>Thickness</th>
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</thead>
<tbody>
<tr>
<td>Existing wall</td>
<td>10 mm</td>
</tr>
<tr>
<td></td>
<td>300 mm</td>
</tr>
<tr>
<td></td>
<td>25 mm</td>
</tr>
<tr>
<td>On-site installation</td>
<td>100 mm</td>
</tr>
<tr>
<td></td>
<td>19 mm</td>
</tr>
<tr>
<td></td>
<td>120 mm</td>
</tr>
<tr>
<td></td>
<td>15 mm</td>
</tr>
<tr>
<td></td>
<td>19 mm</td>
</tr>
<tr>
<td></td>
<td>30 mm</td>
</tr>
<tr>
<td></td>
<td>29 mm</td>
</tr>
<tr>
<td></td>
<td>6 mm</td>
</tr>
</tbody>
</table>

Existing wall

Pre-fabricated module

On-site installation

Pre-fabricated façade module
### House No. Before renovation - After renovation

<table>
<thead>
<tr>
<th>House No</th>
<th>Before renovation (kWh/m²a)</th>
<th>After renovation (kWh/m²a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,6,8</td>
<td>184</td>
<td>9,6</td>
</tr>
<tr>
<td>12,14</td>
<td>225</td>
<td>9,6</td>
</tr>
<tr>
<td>3-19</td>
<td>142</td>
<td>13,6</td>
</tr>
</tbody>
</table>

*Source: hohensin architektur*
One building side is closed.

Sequence of assembly of the façade modules [Kulmer Bau]
First module is the lowest one. It is mounted on steel-bearing angles, which are fixed on the plinth. All other modules rest on the previous one. Therefore all joints are horizontally designed.

Module dimension: 12 x 3 m
Dimension of modules is fixed by the line of the intermediate floor and the window lintel.

Concept of pre-fabrication

Sequence of pre-fabrication procedure in the fabrication hall [Gap-Solution GmbH]
First motivation

School owners and financiers like municipalities, public authorities and their real estate companies need advice on qualitative and financially balanced measures!
Biggest motivation

... is the user’s comfort!

Source: www.baupiloten.com
Wood in School

Wooden classroom

Tables are topped with solid wood panels, and the legs are made of solid beech. The seats and backrests of the chairs are made of plywood, while the frame and legs are solid wood.
Wood is the primary material in our constructions and has numerous advantages over other structural materials. Apart from the eco-friendly production, wooden construction is also extremely important in ensuring the highest health and living standards, which plays a great role in the key phases of physical and mental development. Wood emits no harmful substances, causes no allergies and regulates the humidity level in rooms. A wooden building provides living comfort at as few as 18 – 20 °C. A brick building would only provide such a level of comfort at 22 – 24 °C. Room temperature decreased by one degree means 5-6 percent heating cost savings.
The woodworking industry – major, important employer in many of the Member States of the EU

- Woodworking industry – 2.5 million people in the EU27.

- The total number of companies in the EU27 is estimated at 380,000 (including the furniture industry).

- Unemployment rate has never been higher in the EU (10% in November 2014)

► the woodworking industries have difficulties of finding skilled workers and attract them to work in a woodworking company.

Background
The Vision

Comprehensive school renovations

→ there are very good known examples
→ there are useful tools and awareness projects
→ there are well-trained craftsmen
→ there are platforms actively exchanging ideas
Technologies Concerned

- Timber prefabrication (integrated facilities)
- Ventilation (indoor air quality)
- Intelligent Daylight / Shading (control)
- Renewables (integrated in heating, DHW)

… try to integrate all these topics into comprehensive concepts!
Best practice of school renovation #1-18

ROMSDAL SECONDARY SCHOOL

Main and glitter district Council adopted the school building program in December 2017. The major energy related targets were to achieve building standard and energy label A. This was achieved in the renovation, to use “new” self-sufficient systems to supply energy, to reduce the greenhouse house emissions, and add an A+ building energy management system in the solution.

1. Romsdal Secondary School
2. Sørselde Primary School
3. Risør Technical College
4. Backsippans Pre-school
5. School OVO Heusden-Zolder
6. Delmold Vocational College
7. Gymnasium Reutergersagen
8. Schwanenstadt
9. Rainbach
10. Neumarkt
11. St.Leonard
12. Tišina kindergarten
13. Lavrica kindergarten
14. Kekec kindergarten
15. Storžek kindergarten
16. Siemianowice
17. Vibeingen
18. Capriva del Friuli kindergarten
Best practice-example: VIBEENGEN PRIMARY SCHOOL

The main energy related targets were to achieve the best Danish low-energy class. Partially prefabricated facades are used.
DESCRIPTION OF CONSTRUCTION

Partially prefabricated timber facades was used. The structural system is steel columns and beams with slabs and stabilizing walls of concrete. The prefabricated timber facades are made from 245+95 mm timber with the vapour barrier positioned in between the posts. The average U-value is 0,13 W/m²K.

Only cladding was mounted on site.

GENERAL INFORMATION

<table>
<thead>
<tr>
<th>Location</th>
<th>Haslev, Denmark</th>
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<tbody>
<tr>
<td>Project type</td>
<td>New building</td>
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<tr>
<td>Net cost</td>
<td>21,3 million EURO</td>
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<tr>
<td>Main contractor</td>
<td>BNS</td>
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<tr>
<td>Architect</td>
<td>Arkitema Architects</td>
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<tr>
<td>Building owner</td>
<td>Faxe Municipality</td>
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<tr>
<td>Gross floor area</td>
<td>6 430 m²</td>
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<tr>
<td>Number of storeys</td>
<td>2</td>
</tr>
<tr>
<td>Construction time</td>
<td>October 2011-april 2014</td>
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</table>

TECHNICAL SOLUTIONS AT A GLANCE

- Low-energy school building with the primary energy consumption of 41 kWh/m²
- Sinks only have cold water to minimize water consumption and standby energy consumption
- Partially prefabricated timber facade
- Hybrid ventilation (mechanical and natural)
- Pre-heating of intake air in ground ducts to avoid freezing of heat exchanger
- Extensive use of daylight, e.g. via skylight
- LED lighting
- Natural gas and PV
LESSONS LEARNED

The pre-fabricated facade solutions serves as best-practice and has been described and published in a guideline from the wooden industry.

VENTILATION AND INDOOR AIR QUALITY

The star-shape of the building is designed to augment the potential of hybrid ventilation.

During the heating season, the ventilation in sport and common areas are handled by central balanced mechanical units with heat recovery located in the basement. The fresh air intake is through a ground duct for pre-heating during freezing periods. In classrooms, decentralized balanced mechanical air handling units are designed for max 1000 ppm CO₂.

During summer and sunny periods, airing is handled by a combination of cross-side and stack-assisted natural ventilation, only supported sporadically by the me-

ENERGY DATA / SUPPLY

The school was planned as a low-energy building with a primary energy consumption of 41 kWh/m² GFAa.

Passive measures saves 56 % primary energy compared to Danish Building Code target at the start of the project. The installed PV system reduces it further to zero-energy consumption. The total energy consumption of the school is measured and presented to pupils on the screen located centrally in the school. Detailed power consumption for ventilation, lighting and other equipment is monitored in three classrooms.

The energy is supplied by a boiler using natural gas, and 1435 m² PV's (435 m² on roof, 1000 m² on the ground).
Plattform

“Diversity in School Design” platform
1 May, 2014

The architectural discipline is able to set landmarks for social changes – the design of schools that create an open and diversity oriented atmosphere....

Is there a better place to drive change than in school?
Modular renovation with prefabricated wooden elements

With this survey we try to find some answers on the possible triggers and barriers for the use of modular prefabricated renovation methods to improve the indoor air comfort and energy use of existing school buildings in the EU.

University of Ljubljana | Manja K. Kuzman
Green public procurement

The regulation of Green Public Procurement aims to reduce the negative environmental impact.

30% of wood compared to the entire volume of material of the load-bearing construction for buildings.

Opportunity for public buildings ....

Good practice!!!!
Communities support the wood!

Would you be willing to invest more money in your municipality in order to provide for an environment, which would have a positive impact on people?“

► 79% yes, 17% no, 4% don’t know

In your opinion, in what proportion wood / wood produts could be installed in new public buildings in your community?

Source: The Slovenian public opinion survey on wooden buildings (2)2015 | University of Ljubljana | selected municipalities as a potential investors|
The Kekec Kindergarten

Ljubljana

Building for education

Year | 2010
Architect | Jure Kotnik, Andrej Kotnik
Architectural firm | Arhitektura Jure Kotnik
Structural engineer | CBD d.o.o.
Energy efficiency | low-energy 40 kWh/(m²a)
Surface | 123 m²
Site area | 250 m²
U value (W/m²K) | wall 0,20, roof 0,19, window 1,20, glass 0,70, frame 1,50
Construction system | panel construction
Construction company | Riko Hiše d.o.o.
Čas gradnje | Construction time | 2 months
The Polzela Kindergarten

Building for education
Investor | Občina Polzela
Year | 2013 project, 2014 construction
Architecture | Mojca Gregorski, Matic Lašič
Architectural firm | MODULAR arhitekti d.o.o.
Structural engineer | Proding d.o.o.
Energy efficiency | low-energy 38 kW/m²a
U-value (W/m²K) | wall 0,12, roof 0,11, window 1,10
Surface | 740 m² brutto (new development) + 83 m² (reconstruction)
Site area | 3170 m²
Construction system | timber-frame
Construction company | Remont d.d, Rubner, Avstrija
Construction time | 5 months
House technique | floor heating, comfort ventilation with heat recovery, biomass heating systems - preparation
The Poljčane Kindergarten

Poljčane

Building for education
Investor | Občina Poljčane
Year | 2012 project, 2014 construction
Architecture | Mojca Gregorski, Miha Kajzelj, Matic Lašič
Architectural firm | MODULAR arhitekti d.o.o.
structural engineer | CBD d.o.o. (wood), GRAVITAS d.o.o. (concrete)
Energy efficiency | low-energy
U-value (W/m²K) | wall 0.16, roof 0.12, glass 0.50, window 1.10
Surface | 2760 m²
Site area | 7405 m²
Construction system | massive wood construction
Construction company | GP PROJECT ING d.o.o (Hoja d.d., HASSLACHER Holding GmbH)
Construction time | 18 months
House technique | water to water heat pump, floor heating, comfort ventilation with heat recovery, rain water collector, biological wastewater treatment plant
Project: What We Wood Believe?

Acronim: W3B - Wood Believe

Societal perceptions of the forest-based sector and its products towards a sustainable society

Partners:
- Kompetenzzentrum Holz GmbH (Wood Kplus) – leader
- University of Helsinki (OoH)
- UNIQUE forestry and land use GmbH (UNIQUE)
- University of Ljubljana (UL), Department of Wood Science and Technology
- University of Primorska (UP) FAMNIT

Time: 2014 - 2017

Main focus: Competitive customer solutions

Value: 738,000 EUR
Creating and demonstrating innovative cost-efficient ways for communicating towards stakeholders the relevance of the European forest-based sector and its products for a sustainable bio-economy
In agreement with the public nothing can fail, without public acceptance nothing will succeed”.

Abraham Lincoln