Kamínky 5, Brno-Nový Lískovec

Project summary

Energy concept: Renovation to low-energy standard

Background for the renovation – reasons:

Intention for the renovation:
- Modernization of aging school building
- Improvement of inner conditions
- Reduction of overall energy consumption to comply with low-energy standards

Site: Kamínky 368/5, 634 00 Brno-Nový Lískovec, Czech Republic
Altitude: 312 m
Heating degree days: 3712 Kd (base temp. 13°C)
Cooling degree days: 0 Kd
Owner: Statutory City Brno
Architect: MENHIR projekt, s. r. o.

Contact Person: Mgr. Pavel Petr (headmaster)
Important dates:
Start of the renovation: 06/2009
End of the renovation: 12/2010
Date completed: October 16th 2014

Building description / typology:
- Elementary school with consisting of 3 blocks (classrooms, kitchen and cafeteria, gymnasium)
- Built: 1987
- Maximum capacity: 380 students, 44 staff
- Net heated floor area: 7296 m²

Street view of the school’s main block before (left) and after (right) renovation. [1]
Building envelope, heating, ventilation, cooling and lighting systems before the energy renovation

Description of building (building situation, building system, renovation needs and renovation options.

The buildings of Elementary School Kamínky 5 were constructed in 1987. The school consists of 3 blocks connected via multi-storey corridors. The main block (A) where the classrooms and offices are located, kitchen and cafeteria block (B) and gymnasium (C).

The maximum capacity of the school is approx. 380 students and 44 staff members. Total net heated floor area of school buildings is 7296 m².

Building envelope

The construction of the building corresponds with the period of origin – superstructure is made of prefabricated reinforced concrete frame MS-OB with basic length module 6.0 m. Walls are made mostly of 300 mm thick ceramic panels. Part of the walls is built using aerated concrete blocks.

All buildings have flat roof. Superstructure of the roof is made of timber or steel trusses and reinforced concrete panels. The roof was insulated by 50 mm of EPS on a sloping layer of gravel. Bituminous sheets with mineral granules (and Ti-Zn flashing) were used as a covering and waterproofing layer of the roof.

Doors and windows were wooden, steel or aluminum, using single or double glazing.

The most heat was lost by the buildings envelope due to the low thermal resistance (U-values) of the structures and bad air tightness (especially around windows)

Heating, ventilation, cooling and lighting systems before retrofit

Heating and DHW systems are supplied by district heating from a nearby (gas burning) heating plant to central (water-water) heat exchanger. No cooling system is installed in the school.

Most of the school uses natural ventilation by windows. Individual ventilators were installed in store rooms, toilets and bathrooms. Only block B had mechanical ventilation.

Bulbs and fluorescent tubes were used for lighting.

<table>
<thead>
<tr>
<th>Element</th>
<th>Area m²</th>
<th>U-Value before renovation W/m²K</th>
<th>U-Value after renovation W/m²K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Façade</td>
<td>3873</td>
<td>1.06</td>
<td>0.20</td>
</tr>
<tr>
<td>Ceiling</td>
<td>5325</td>
<td>0.97</td>
<td>0.15</td>
</tr>
<tr>
<td>Windows, doors</td>
<td>2502</td>
<td>1.50 – 5.65</td>
<td>1.05 – 1.70</td>
</tr>
<tr>
<td>Roof</td>
<td>5325</td>
<td>0.58 – 0.86</td>
<td>0.15 – 0.16</td>
</tr>
</tbody>
</table>

Atrium in the middle of the main block before the renovation. [1]
**Energy renovation features**

**Energy saving concept**

Main goal of the renovation was to improve the user comfort and energy performance of the school buildings.

- After a debate it was decided that the school’s envelope, heating, DHW and mechanical ventilation systems will be renovated according to low-energy standards.
- During the renovation it was decided to install a photovoltaic power plant on the roof to improve the environmental impacts of the building’s use.

**Building**

- Additional thermal insulation (ETICS) made of expanded (EPS) or extruded (XPS) polystyrene or mineral wool was installed on the walls and roof. Also new waterproofing was installed on the roof. New U-values of the building’s envelope vary between ≤ 0.16 W/m2K (roof) and ≤ 0.20 W/m2K (walls).
- Most of the doors and windows in the building’s envelope were replaced. New doors and windows have plastic or aluminum frames with double and triple glazing, with U-value ≤ 1.70 W/m²K. Also a new exterior shading system was installed on classrooms’ windows to improve the user’s (students and staff) comfort during sunny weather.

**Technical systems**

**Heating:** New compact heat exchanger station is located in the basement of block B. The school is heated using 276 (112 original) cast-iron radiators and 8 steel-stone heating desks. The radiators are fitted with thermostatic valves and heads. Steel pipes with equithermal regulation are used to supply the radiators. The temperature gradient in the heating system is 75/55°C. Heating system’s efficiency is 95%.

**Ventilation:** During the renovation the original mechanical ventilation system in block B was removed and replaced by new one (with heat recovery). System’s maximum output is 15000 m³/h of fresh air. Ventilation of storerooms in the basement of block B uses separate ventilation (500 m³/h). The boiler room in block A is ventilated by an overpressure system (500 m³/h). All toilets and bathrooms are ventilated using manually operated ventilators with timers. Storage rooms in the school (except block B) can be ventilated naturally by windows or by new manually operated supplementary ventilators (also manually operated with timers). All ducts are made of galvanized steel and have rubber silencers to reduce the noise (< 50 dB).

**Photovoltaics:** A photovoltaic power plant was built on the part of the A block’s roof during the renovation. 324 PV panels (415.53 m²) with output of 205 Wp per panel were installed. The calculated peak output is 66.42 kWp. The panels are installed at optimum 30°inclined and are oriented to the south. The municipality didn't have enough funds to build the power plant themselves, therefore they agreed to a proposal from a private company – the company rents the roof (where the power plants stands) for a yearly fee. This income is subsequently re/invested in the school. The power plant is connected to the public network, therefore its has only indirect impacts on the school itself.
Achieved energy savings, CO₂ reductions and costs

<table>
<thead>
<tr>
<th>Before renovation</th>
<th>Energy consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating:</td>
<td>386.01 MJ/m²a</td>
</tr>
<tr>
<td>DHW:</td>
<td>53.13 MJ/m²a</td>
</tr>
<tr>
<td>Total:</td>
<td>439.15 MJ/m²a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>After renovation</th>
<th>Energy consumption</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating:</td>
<td>127.33 MJ/m²a</td>
<td>67.0 %</td>
</tr>
<tr>
<td>DHW:</td>
<td>50.21 MJ/m²a</td>
<td>5.5 %</td>
</tr>
<tr>
<td>Total:</td>
<td>177.54 MJ/m²a</td>
<td>59.6 %</td>
</tr>
</tbody>
</table>

Energy savings and CO₂ reduction

Thanks to improved thermal properties of the school buildings’ envelope and renovation of the heating system the heating energy consumption was reduced by 67 %.

Retrofitting of heating and DHW system lead to 5.5 % savings of energy required for DHW production and distribution. This little decrease in energy consumption can be questioned, because it does not truly describe the efficiency of the renovation. As a part of the renovation of the DHW system the original DHW circulation circuit (previously out of order – clogged with scale) was repaired. This caused increase in the DHW consumption. Despite this the overall DHW energy consumption still decreased, which proves the efficiency of the renovation.

Note: All the data about energy and CO₂ reductions are related to the net floor area.

| Calculated CO₂ production before renovation | 58.9 kg CO₂Eq./m²a |
| Calculated CO₂ production after renovation | 34.9 kg CO₂Eq./m²a |
| Reduction:                                  | 40.7 %              |

Renovation costs

| Total | 39.0 Million CZK |

This amount includes all the costs related to the renovation – the renovation of the building, renovation of the outdoor sport facilities and restoration of the surroundings to the original state.

Energy production

Photovoltaic power plant installed on the roof of the school's block A has maximum calculated output 66.42 kWp.

Between September 2009 (installation) and February 2014 (this report) the power plant produced 334.39 kWh of electricity.

The power plant is owned by a private company and supplies electricity to the public network. The municipality receives a payment of 60000 CZK annually for renting the school's roof to this purpose.
Overall improvements

Energy benefits
Energy savings: 261.04 MJ/m²a
(heating, DHW, ventilation, lighting)
Energy from PV: ~ 260.93 GJ/a

Indoor climate technical improvements
The indoor climate was improved due to:

• Renovation of the school’s envelope. This reduced the heat losses and improved thermal stability of the rooms. Thanks to the better air tightness the previously common drafts (through the original windows) disappeared.

• Partial replacement and re-regulation of the heating and DHW systems improved their efficiency and ease of use.

• Installation of exterior shading sunblinds on the windows improved problems related to overheating in summer.

Non-energy benefits
Overall the renovation of the school buildings and grounds improved:

• Comfort of the users (students and staff). E.g. the new equipment is easier to use and maintain.

• New possibilities for active spending of leisure time for students and general public are open thanks to the new sport facilities

• Overall improvement of people’s perception of the building and surroundings

Aerial view of the renovated school and its surroundings. [3]
Summary

Three blocks of Elementary School Kamínky 5 in Brno – Nový Lískovec were renovated. The building envelope (walls, roofs, ceilings and floors) was insulated using EPS, XPS and mineral wool. New waterproofing was installed on the roof. Heating, DHW and lighting systems were partially replaced and reconstructed. To decrease the negative environmental impacts of the operation of the school a photovoltaic power plant was installed on the roof of the school’s main block. Above mentioned measures decreased heating and DHW energy consumption by 59.6 %. Also the renovation has positive socio-cultural impacts – the aesthetic value of the school had risen due to the renovation. Also the surroundings of the school (playgrounds, park, etc) were renovated and refurbished during the construction.

Acknowledgements

Special thanks belong to:
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References