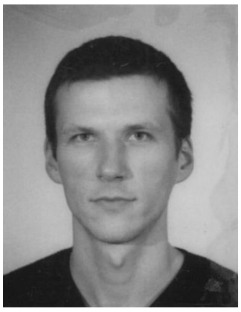
BUILDING OF ECOLOGICAL EDUCATION CENTRE SLUNAKOV

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Summary

The paper deals with the design of the Ecological Education Centre Sluňákov. An architectural design and building-energy concept that minimizes building energy demand and focuses on the utilization of renewable energy sources and materials are presented.

Keywords: Low-energy building, education centre Sluňákov, passive house components

1 Introduction

The Sluňákov Ecological Education Centre (SEV) has been designed for the city of Olomouc as a part of the project entitled “Sluňákov, facilities for ecological activities – educational biocentre in Horka nad Moravou”. The facilities are used for education of the public about the environment and its processes and to support public environmental awareness. The SEV building is used as the entrance to the Nature Protection Area of Litovelské Pomoraví. The facilities are located about 10 km northwest of Olomouc in Haná, in the Morava River valley, not far from the river’s branch of Mlýnský potok.

The Centre itself is used for a wide range of activities. The main aims are providing one-day and weeklong environmental education programs for school-aged groups. In addition, professional seminars on ecology, education and related topics are held here. A part of the Centre is used for tourists visiting the information centre of the Nature Protection Area of Litovelské Pomoraví and the nature area around Haná. The building also enables “soft tourism” that includes environmental education programs.

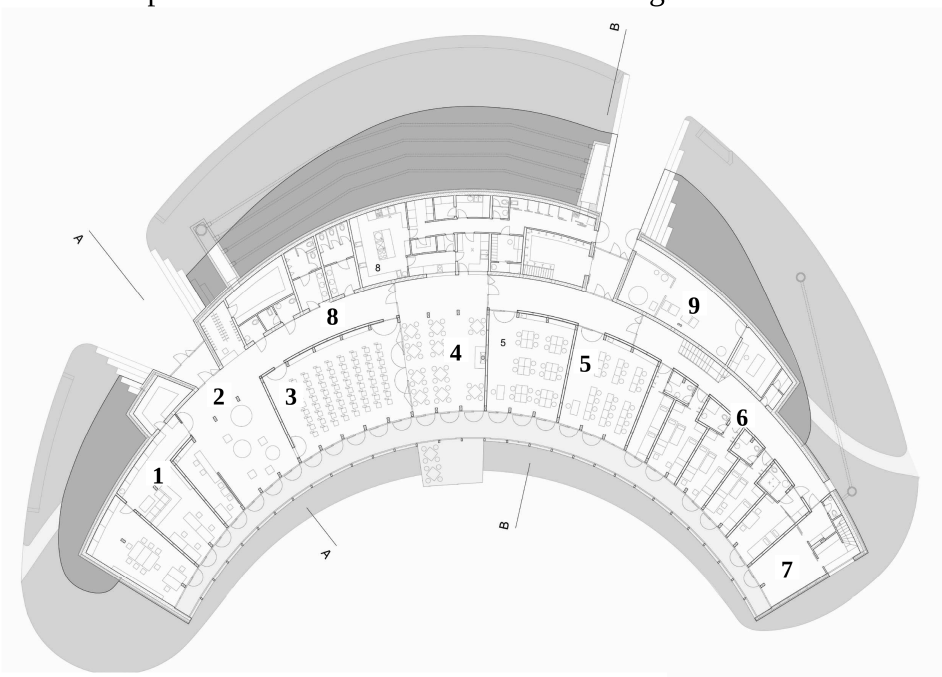
Because the SEV Centre has been designed as an energy-saving building that uses modern elements of alternative energy sources, it will also provide the public with an example of the possibilities available when designing ecological housing and promote sustainable development.

2 Architectural design

The building has been designed as a curved inhabitable land wave – a dune that fluently blends into the surrounding terrain. The building's ground floor is raised to ensure that it is above flood level. The building is symmetrical following the exact North-South axes. The architectural design utilizes the southern orientation and the eastern orientation. Two recessed entrances are situated at the north side.

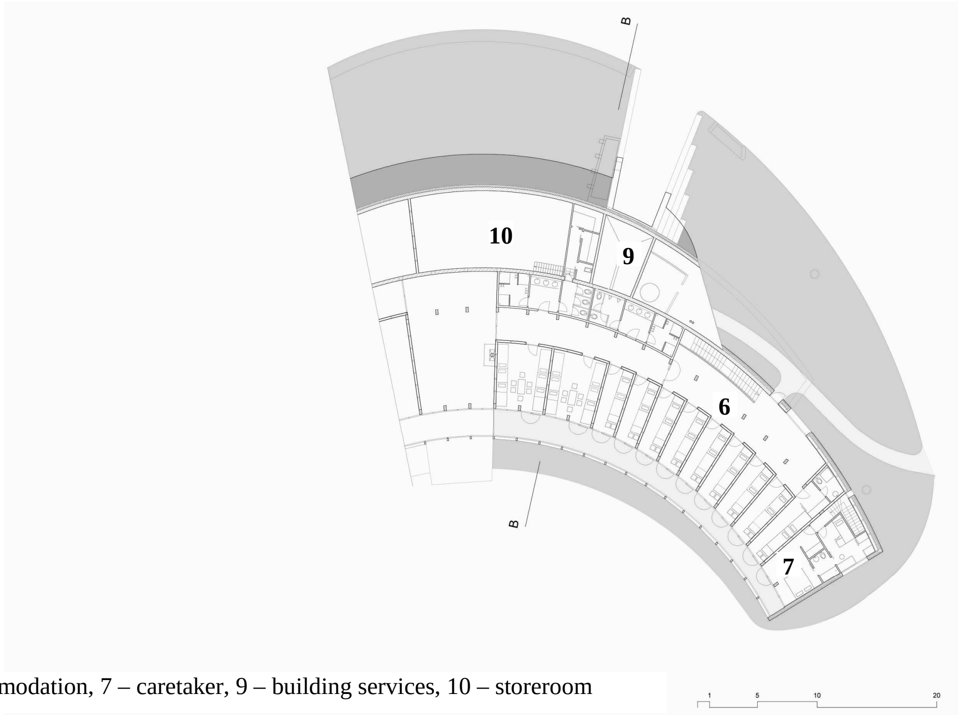
The western side of the building symbolically ascends from the ground to enhance the display of the south-western sunshine. The earth-sheltered northern side of the building fluently adjoins the building's earth-covered roof, which gradually increases in height from the west to the east, so that half of the building is one-storey and the other half is two-storey. The earth-covered roof is an important part of the urban concept. The path that leads the visitor from the main entrance over the "ridge" of the building goes on to the "top" lookout point that provides a unique view of the entire SEV nature facilities. The area between the building and the artificial mound in front of the southern façade is used as a living garden for the facilities' guests and visitors.

The unusual style of the proposed building results from a process of looking for new forms of ecological buildings that not only integrate into the surrounding environment, but also utilize solar energy and are earth-sheltered to increase protection from unfavorable weather. The form proposed was inspired by the low-to-the-ground, rustic buildings traditionally found in Haná. The interior is simple and easily legible. The shape of the solar eclipse served as inspiration for the curvature of the building.



1 – Admistration, 2 – entrance hall, 3 – lecture hall, 4 – canteen, 5 – classroom,
6 – accommodation, 7 – caretaker, 8 – kitchen, 9 – building services

Fig. 1 Ground floor plan



6 – accommodation, 7 – caretaker, 9 – building services, 10 – storeroom

Fig. 2 First floor plan

All materials used are traditional and have been chosen due to their environmental friendliness. The facades are covered by wood (industrially or manually rough-worked), glass and stone (stacked) and grass. The interior is completed using mainly wood (in its natural form and agglomerated form (OSB) for the supporting structure and partitions walls), glass, brick walls (for supporting and partition walls on the ground floor) plastered or in the case of unfired brick left uncovered. Fired brick or reinforced concrete is used in the supporting structure for the technical rooms and wet activity areas. Most floors are covered by wooden planks and those in wet activity areas or in technical areas are covered by ceramic tiles. The entire concept of the interior and exterior of the building is based on reality and takes into account the use of natural colours and surface structures of the individual building materials.

Not only does the building have passive building elements (glazed façade on the south side, earth shelter on the northern side) that enable the building to save on energy and help the environment, but also active measures. These measures, such as heating and ventilation using heat recovery, solar collectors for hot water heating and for support of space heating, earth-to-air heat exchanger, will also be used along with the others for educational and demonstration purposes.

From the point of view of construction, the building is divided into two different parts. The northern part is a concrete skeleton construction filled by unfired brickwork, the southern part with hallway and main spaces with load bearing structure made by wooden frames. The southern volume has partially one floor (lecture halls, offices), partially two floors (accommodation).

Flexibility, which is perceived as beneficial to the ecological concept of the entire building, was stressed when solving the problem of room plan. The backbone of the building is the hallway that runs the entire length of the building. All rooms are accessible from the hallway.

3 Building-energy concept

The building-energy concept was designed with respect to the basic principles of sustainable development. The building is designed for full yearlong operation with the four month heating season only. The heat demand is covered using a combination of renewable energy sources – biomass and solar energy.

The building envelope was designed so that it meets all the recommended U - values (thermal transmittances) according to the national standard CSN 730540:2 (2002). The particular constructions are described in **Tab. 1**.

The heat demand for heating (**Tab. 2**) was estimated according to EN ISO 13790 calculation scheme. The values of air flow rate and internal heat gains were for calculation are estimated from mean occupancy expected during heating period. The amount of fresh air to be brought into the heated space is 610 m^3/hour; the heat recovery efficiency is considered as 70 %. The calculated heat demand for space heating is 41,9 MWh/year, the specific heat use is 8,5 kWh/(m^3year). This is approx. 24 % of corresponding admissible value (form factor A/V = 0.58 m^2/m^3) according to present Czech legislation.

Tab. 1 Thermal transmittances

building element	**U [W/(m^2K)]**		**description**
	obligatory	design	
roof	0,24	0,15	OSB boards, bitumen based water vapour barrier, expanded polystyrene 280 mm, water proofing system, filtration textile, vegetation layer
external wall bellow the ground	0,45	0,20	concrete wall, bitumen based waterproofing, extruded polystyrene 180 mm, protection textile
external wall	0,30	0,20	wooden cladding, un-ventilated air-cavity 40 mm, water vapour barrier, mineral wool 160 mm, OSB board, mineral wool, diffusive moisture protection foil, wooden cladding
floor on the ground	0,45	0,22	wooden boards, mineral wool 240 mm in wooden frame, concrete plate, bitumen based waterproofing
window	1,7	0,9 - 1,1	wooden frames, triple glazing

Tab. 2 Energy parameters (heating)

Heat loss coefficient according to EN 832	986 W/K
Design heat load (for -15 °C)	36 kW
Mean thermal transmittance	0,25 W/(m^2.K)
Heat use for space heating	41,9 MWh
related to 1 m^2 heated area	30,5 kWh/(m^2a)
related to equivalent 1 m^2 heated area (considering the “double-height” of some spaces)	25,1 kWh/(m^2.a)

The building is divided into six zones; each zone has its own ventilation unit, individually operated. The accommodation rooms are equipped by mechanical ventilation (balanced ventilation with heat recovery, without air circulation) covering the ventilation heat loss and by small low-temperature convectors covering transmission heat losses. The other zones, such as lecture hall and administration, are equipped by ventilation warm-air heating. Ventilation and at the same time air heating is ensured by fresh air ventilation with heat recovery (secondary circuit) and by warm air circulation (primary circuit).

Earth-to-air heat exchangers that serve mainly to bring cooler air inside during the summer months are located in the thermal mass (soil mound) behind the building. These exchangers help to improve the average internal air temperature during the summer season. In the transitional seasons the fresh air is taken from the inlets found on the sidewalls of the entrances directly. The first exchanger brings the cold air to the administrative part of the Centre. The second exchanger serves the accommodation areas. Because of the lack of space, the pipes are horizontally placed one above the other. The third exchanger cools the caretaker accommodation. The earth-to-air heat exchanger designed for the Centre is a system yet to be realized to such an extent in the Czech Republic.

Two automatic wood pellet furnaces, each with an output of 50 kW, provide the main source of heat for heating and are a supplementary source for hot water heating. The pellets are stored at the back of the building close to the technical entrance and are transported to the furnaces pneumatically.

A modern low-flow solar system (total absorption surface 85 m^2) that decreases the need for secondary energy (pumping) has been designed so as to cover the significant part of hot water consumption (70 %) and the part of heating demand (up to 20 %). The irregularity of solar energy supply during several days is balanced using short-term accumulation. A solar storage tank is located on the first floor in the technical room next to the furnace for pellets. The 12,7 m^3 storage capacity of the tank not only meets the needs of heat for hot water preparation, but it also supports the space heating during the transitional periods. A completely heated tank may ensure hot water preparation for 4-5 days of no sunshine. The pressureless solar tank has special in-built ducts in order to enable storage in temperature layers, i.e. in a stratified manner. The hottest top layer enables immediate heat consumption shortly after the solar system has started to work.

A control system in the technical room collects high number of input data (temperature, energy flows etc.), evaluates the actual performance and decides about optimal energy strategy according to given schedule of occupancy of the building.

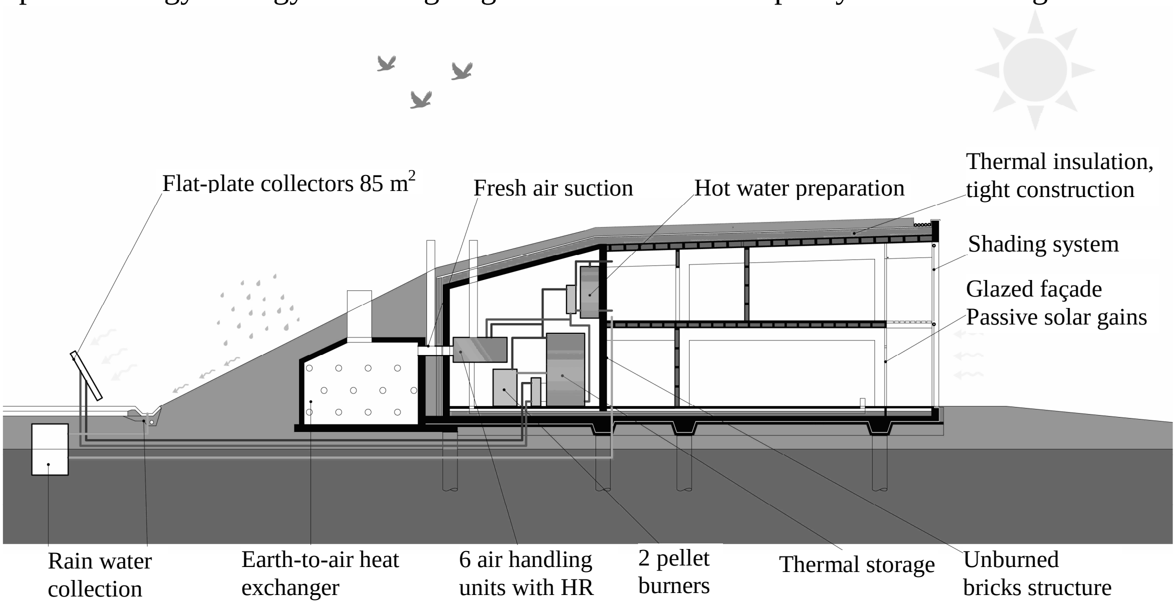


Fig. 3 Building energy concept

4 Conclusions

Fig. 4 Southern glazed façade

The building is in operation since January 2007. The acceptance by the public seems to be quite high. Several educational programs for children and for public are already running. The building creates a very good milieu for information activities dealing with environmentally friendly building design.

The overall energy performance and indoor air quality are subjects of the longtime monitoring. It is obvious that staff here needs some period of time to handle the quite complex technical services in an optimal way. This is concentrated on setting target values of indoor parameters according to expected time schedule of occupancy and the weather condition. Project partners from CTU in Prague provide some support in this respect.

The design was awarded by National Grand Prix of Architects 2007 and by Environment Minister Award 2007.

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References

[1] http://www.slunakov.cz

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