1. Project Overview

The 126 m² Szada family house is the first certified passive house in Hungary. The design and construction took place in 2008, the owners moved in the house in February 2009. The construction system is insulated concrete form, with conventional pitched roof. The design and construction together took only 8 months, and the costs were kept low, so this is a real affordable passive house. The project was certified by the the Energie Planer Team in February 2009, and became an iconic project, inspiring other passive house projects in Hungary.

Key environmental strategies: Solar thermal vacuum panel for hot water and heating with 500 L storage tank, proper orientation maximising solar gains, appropriate shading, vernacular elements, independent cold cellar, vegetation shaded carport, biogarden for vegetable production, builder participation in construction, pellet heating

<table>
<thead>
<tr>
<th>U-value external walls</th>
<th>0,09 W/m²K</th>
<th>PHPP Space heat Demand</th>
<th>13 kWh/m²,a</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-value floor</td>
<td>0,12</td>
<td>PHPP Primary Energy Demand</td>
<td>110</td>
</tr>
<tr>
<td>U-value roof (upper slab)</td>
<td>0,05</td>
<td>Airtest</td>
<td>0,43/h</td>
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<tr>
<td>U-value windows</td>
<td>0,75</td>
<td>Heat Recovery Unit Efficiency</td>
<td>88,00%</td>
</tr>
</tbody>
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2. Brief Project Description

Designed by Intervallum Architects (László Szekér), the insulated concrete form 126 sqm three bedroom home has predicted annual heating bills less than 90% of an average same size conventional home in Hungary (at standard occupancy maintained at 20 ºC in winter). This is achieved by high level of insulation, triple glazing, draught free construction, very efficient heat recovery ventilation system, cold bridge free construction, earth cooling and appropriate shading with night ventilation in the summer.

The site is located in Szada, some 30 km from the capital city of Budapest in a new residential quarter. Because of the new construction, the proper solar access was achievable by consulting the neighbours and the local municipality for optimum site layout. Biodiversity is supported by the bio vegetable garden maintained by the owners, feeding (partly) the three kid family.

This project is the first certified passive house in Hungary, and is the result of the combined effort of its designer and builder participants. The house was opened for the public during the first time in 2009 November, and is a reference for many passive house builders, because it proved, that it is possible to build an affordable passivehouse in Hungary at no extra cost compared to average.

The Szada passive house became an iconic building, despite its simple form, and had an extensive media coverage. Public opinion likes the architect's approach mixing vernacular forms with cutting edge construction solutions. The low-cost realization (236.000 Huf/m2 appr. 850 Euros/m2) is an answer for those who claim passive house technology is expensive. This figure gives a hope for those, who have limited budget, but interested to build a passive house in the future, and keep heating bills low forever. The persons and companies taking part in the realization of this project became the founders of the National Association of Passive House Builders (NAP) - in Hungary called PAOSZ. (Passzívházépítők Országos Szövetsége).
2.1 Ground floor plan: simple forms, spaces are divided into day and night zones.

2.2 The start of the construction, József Benécs (mech. Engineering, PHPP, supervision, Attila Béleczky ICF supplier, László Szekér architect)

Construction details
2.3 The location of the building

The site is designed according to the best possible solar access, so the position of the house is in the middle of the plot, which required special negotiations with the neighbours and the local municipality.

2.4 Elevation drawings. Drawings show the not realized sliding shutters.
2.5 Perspective view from south-east

3. Construction details

Rehau ventilation tubes; Kardos Labor's vacuum tube solar collector and Baucell's ICF element using Neopor graphite insulation; Blower-door test; wall construction.
4. Section of the house, special design considerations

The typical section shows the technical details, the special foundation and cold-bridge free construction; the superinsulation, specially the top slab; the open, ventilated pitched roof, which serves as possible future extension; the optimized roof overhang for summer shading; the house opens up to the south direction and closes to the north; a wind-catcher north vegetation covered open carport; there is no garage, heated cellar, staircase, and other expensive solutions.

The main entrance of the house is from north side through an entrance lobby, which controls the infiltration when entering the house. The space division of the house is simple, dividing into a day and night zone. The living room is connected to an open covered large terrace, a modern version of the popular vernacular „tornác” (verandah). The roof form refers to the North-Hungarian „palóc” style. The windows are partly fixed, in order to reduce costs.
5. Construction details:
Loadbearing slab foundation; the first row of the ICF elements; wall construction; slab construction; Rehau ventilation pipes in the earth; construction of the floor heating system;

6. Roof construction details - the roof was constructed in 3 weeks with transylvanian carpenters
7. Airtightness

was relatively easy to achieve. Special attention was focused on the windows installation, and closing of gaps. The construction itself is airtight. For interior walls we used heavy brickwork, for thermal storage. The appr. 150 tonnes of concrete (slabs and walls) works as a seasonal storage, and keeps the temperature. During test period, in the winter of 2008-2009 the temperature did not drop below 16 °C without any heating and unoccupied. When a couple of people entered the house (e.g. The blower-door test) temperature began to rise to 18-19 °C, without any heating, demonstrating to the people present their thermal contribution the the active heating load.

8. Ventilation

There is a service room in the house, which is the space for washing and drying as well as utilities, and houses the heat recovery ventilation unit and the hot water tank. The premise is inside the thermal envelope. The air intake is from the rear side of the garden, and via 60 m long 200 mm thick collector tubes preheat the air during winter, and precool it during summer. The air temperature is controlled, and uses renewable sources. The air ducts are hidden in the ceiling slab, utilizing the built-in hollow elements, as natural ducts. The ducts are kept as short as possible to maximize efficiency. The heat recovery ventilation unit is PAUL Atmos 175 DC with 88 % efficiency. The ventilation system helps to distribute solar gains, and occasionally needed extra floor heating. For summer period the ventilation system works as natural cooling system, utilizing the cool earth temperature for free cooling. The 2 year test period showed, that the building works as predicted, with very low heating demand and no mechanical cooling demand in the summer.
9. PHPP

The house was designed from the first sketch with PHPP. The extent of insulation, architectural form, eaves overhang and ratio of glazing etc. was modified because of the PHPP. The final design was also controlled by he PHPP successfully.

10. Costs

Costs are appr. 850 Euros/m2 incl. Taxes. (236.000 HUF with VAT). From the very first sketch the owner and builder has set a financial limit of 30 Million HUF – appr. 110.000 Euros – all inclusive. The task for the architect was to fulfill the desires of designing a new certified three bedroom passive house, within this budget. The task was fulfilled for the builder’s delight. The original concept of two-story house was changed for a single floor dwelling, partly because in this way the expensive and useless staircase could be eliminated from the programme. No fancy spaces, garage, cellar etc. was built, with optimized solutions at affordable prices. The owner – a mathematician-teacher couple with three children took part in the physical construction – according to the possibilities.
11. Technical design
Because of affordability, the simplest solutions were designed. Vernacular tradition gave us inspiration. In vernacular architecture, Time, Climate and Nature were the forming forces, only practical solutions with pragmatic approach could survive. Passive house technology was filtered through Hungarian tradition. The owner is very environment conscious, ideal for the owner of the first passive house in Hungary. The owners are very proud of their building, and operate it with care.

12. Experience so far
The client has two full seasons living in their passive house, and have a great experience. The knowledge is shared in on-line forums, conferences, blogs, websites etc., and contribute to the successfull implementation of the passive house idea into practice. The originally designed moveable shutters were not realized (for the designer's sorrow) because of cost saving, and also because of the efficient roof shading they are not needed in the summer. Partly because of this, there is a strange experience of occasional overheating in February, which is very unusual in Hungary, having a strong winter. The shading was designed so, that only high altitude is protected, low sun angle can enter the house. Probably because of climate change, February weather became mild, with intensive sunshine, which has led to overheating a few times. The problem could be solved easily by opening the window. The lack of the cellar lead the client to decide to construct a traditional earth bermed cold cellar, particularly for storing vegetables, wine etc. The originally designed stone decoration was left out for practical reasons. The empty roof space is used for storage of unused materials etc. and became a useful space.
13. Engineering and materials
Construction engineering was carried out by Ferenc Pap, the roof is standard wood construction, with special solutions regarding cold bridge free construction. All the materials and equipments used for construction were bought in Hungary, achievable on the market. Mechanical engineering was designed by József Benécs, ventilation consultant Mihály Kucsera.

14. Monitoring
The owner monitors the building himself, and keeps a record on the data collected, including bills, temperature data, other experiences etc.

15. Future development
The original idea was to construct an autonomous house, which produces its own electricity, and if possible harvests rainwater for irrigation and toilet flush. These have been postponed to a later time, but still in mind to realize. If there will be a support scheme in the future, these steps will be hopefully realized.
16. **Interior, furniture**
The interior is kept very simple, due to financial reasons. The basic idea for interior design is inspired by the vernacular architecture. Objects and furniture should be simple, practical, and natural. The architects suggested to use wood as basic material for furniture.

17. **Construction details**
Foundation slab and outer wall detail is designed to be a cold-bridge free construction, with specially developed ICF foundation element.
**Outer wall construction:** Insulated concrete form (ICF) with Neopor insulation, 35 cm. The core is 15 cm reinforced concrete, the total thickness is 50 cm. The interior finish is gypsum board.
Windows installation:

Specially designed Internorm edition type triple glazed openings with insulated frame were used, with air-tight details. Appr. Half of the windows were designed as fixed ones.

Window properties:

Internorm Edition Passiv

\[ U_g = 0.6 \text{ W/m}^2\text{K} \]
\[ U_w = 0.75 \text{ W/m}^2\text{K} \]
\[ g = 51\% \]
**Airtight building shell:** Airtightness is achieved by the reinforced concrete structure and the plastering, and the airtight installation of the windows.

**Ventilation and heating:** PAUL Atmos175 DC, HRV with 88% efficiency, earth collectors, vacuum tube solar collectors for hot water, 500 l hot water tank, floor heating, pellet stove

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László Szekér  
Architect