TECHNICKÝ A SKÚŠOBNÝ ÚSTAV STAVEBNÝ
BUILDING TESTING AND RESEARCH INSTITUTE

Retrofitting apartment buildings to reduce energy demand and integrate renewables at Bratislava

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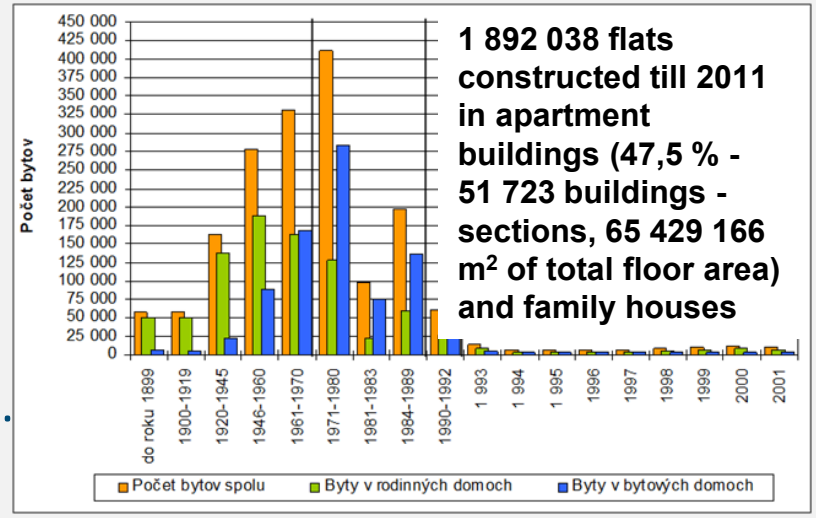
Building stock of SR – residential buildings

» The census in 2021 in Slovakia was conducted according to a new concept, it also includes processing data on the renovation of buildings through the insulation of the external walls (57.46%) and roofs (61.3%) and the replacement of openings (76.54%).

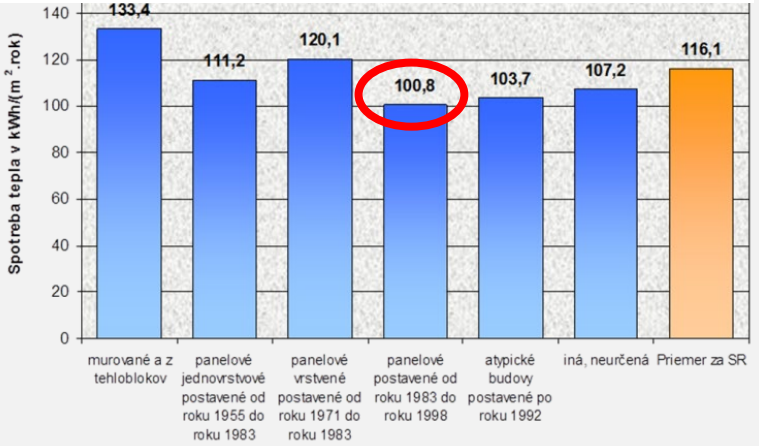


1 892 038 flats constructed till 2011 in apartment buildings (47,5 % - 51 723 buildings - sections, 65 429 166 m² of total floor area) and family houses

Residential buildings and units	**Total**	Total apartment b.	AB (%)
Sume for SR – buildings	**1 234 592**	77 113	6,25
Sume for SR – flats in apartment buildings	**2 235 586**	1 025 735	45,88

» The total number of residential buildings included into the plane of renovation are buildings the buildings constructed till 1996, which arise from the existing database of buildings.

Average heat consumption for heating – apartment buildings in kWh/(m²·a)



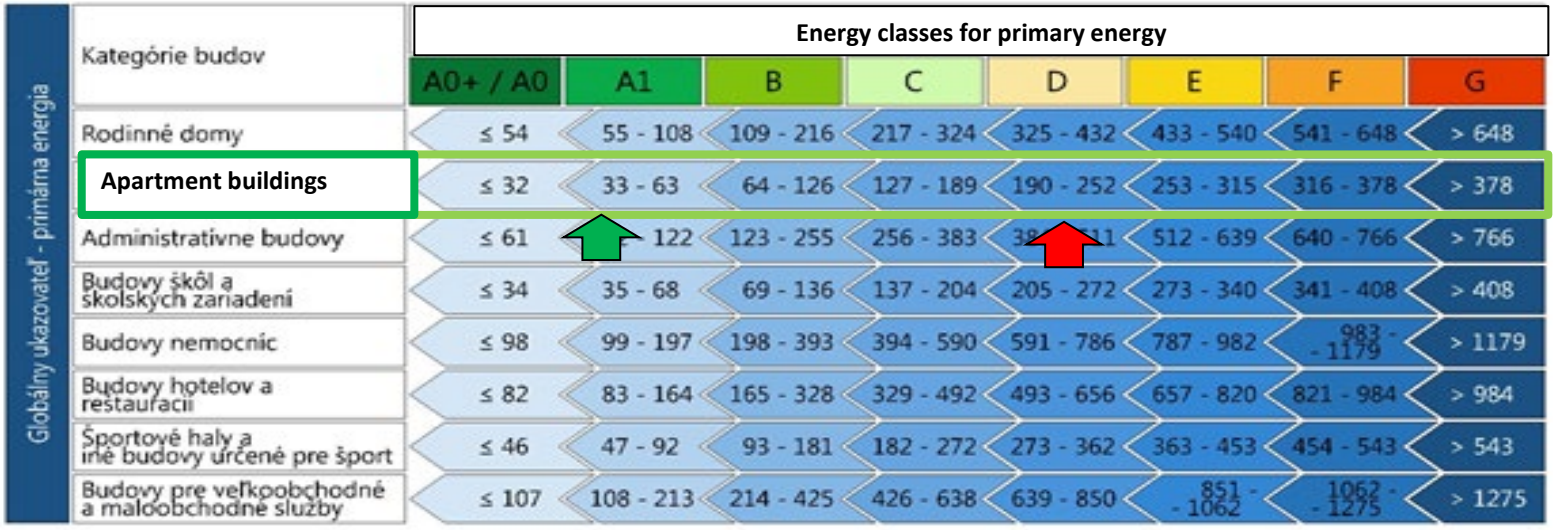
Legal documents and technical standards

- The process of assessing energy performance of buildings (EPB) is related to the implementation of Directive 2002/91/EC on EHB, the revised version 2010/31/EU, and Amendment No. 2018/844/EU into the Building Energy Performance Act No. 555/2005 Coll., as amended by Act No. 300/2012 Coll. and Act No. 378/2019 Coll.
- The law is supplemented by the Decree of the Ministry No. 364/2012 Coll. as amended by Decree No. 324/2016 Coll. The Decree of the Ministry No. 35/2020 Coll., which amends and supplements Decree No. 364/2012 Coll. entered into force on March 10, 2020.
- To the mentioned legal regulations are related STN 73 0540-2: 2012/Z1+Z2: 2019 Thermal Protection of Buildings. Thermal technical properties of building structures and buildings. Part 2: Functional requirements. STN 73 0540-3/Z1: 2025 Thermal Protection of Buildings. Thermal technical properties... Part 3: Environmental and building product properties (setting the data for hourly method of calculation and climatic data) and National Annex STN EN ISO 13790/NA.
- Implementation of EPBD No 2024/1725 is ongoing.

Requirements on thermal protection and EPB

» Stepped tightening of requirements on thermal protection set in 2012

Type of building structure	U-value in W/(m².K)			
	minimal requirement U_{max}	standardized value U_N from 1.1.2013	standardized value U_{r1} from 1.1.2016	standardized value U_{r2} from 1.1.20216
External walls	0.46	0.32	**0.22**	0.22
Roofs	0.30	0.20	**0.15**	0.15
Windows	1.70	1.40	**1.00**	0.85



EU GUGLE project

- **In 2011**, Bratislava responded to the EU's call for the 'FP7-ENERGY-SMARTCITIES-2012' program and applied to participate in the EU international project GUGLE 'European cities serving as Green Urban Gate towards Leadership in sustainable Energy.‘
- The project, funded by the European Commission and part of the 7th Framework Program 'Topic Energy. 2012.8.8.3 Demonstration of nearly Zero Carbon Building Renovation for cities and districts – Reducing greenhouse gas emissions when renovating cities and their parts.‘
- Six pilot cities took in the project part: Aachen (DE), Bratislava (SK), Milan (IT), Sestao (ES), Tampere (FI), Vienna (AT), and two associated cities Gaziantep (TR) and Gothenburg (SE).
- Remarks (used abbreviations):

  EPB – Energy Performance of Buildings

  ETICS – External Thermal Insulation Composite Systems

EU GUGLE project

- The goal of the project was to achieve a concept of energy performance of buildings, to consider the expected reduction in energy demand in residential buildings.
- The project was focused on the implementation of proposed measures, to point on the whole process of deep renovation including schedule and steps of deep renovation, needed skills, finantial tools etc., on confirming the actual achievement of requirements in the field of thermal protection and energy performance of buildings according to the legal regulations and technical standards in force at that time, i.e. ensuring renovation to the level of NZEB taking in the view the results of cost-optimal calculation the minimal requirements of EPB (first calculation in 2013).
- Example of the deep renovation is the apartment building in Bratislava-Devinska Nova Ves, P. Horova street 17, 19 constructed in 1988 using system P.1.14. The renovation took place from September 2015 to March 2016 in two phases (envelope structures and technical systems including disconnection from DH and the installation of RES).

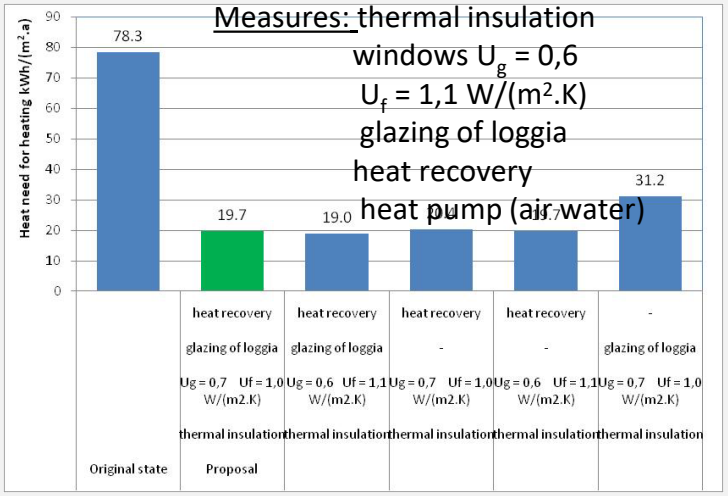
Example of residential building deep renovation

BUILT-UP AREA TYPICAL FLOOR:
540,9 m²
TOTAL FLOOR AREA OF THE RESIDENTIAL AREA:
3 786,3 m²
ENCLOSED VOLUME:
10 774,7 m³
NUMBER OF FLOORS:
7
NUMBER OF HOUSING UNITS:
42

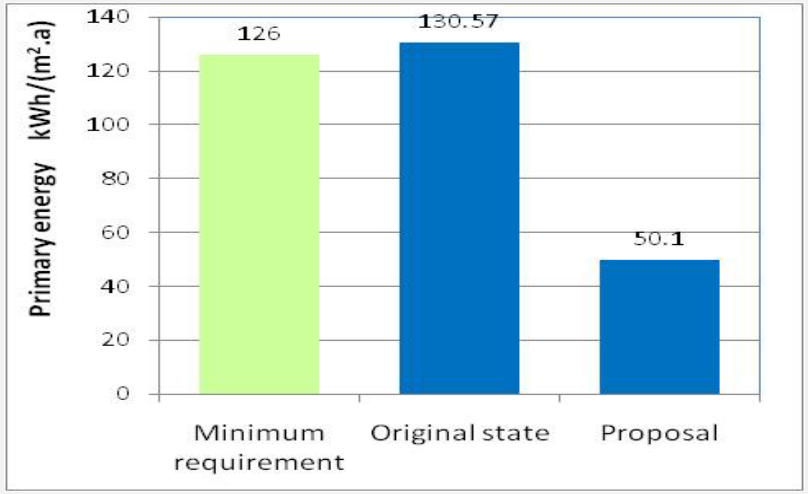
Calculation of structure properties and systems

» Analyses of the structure properties and ventilation impact on heat need

Type of building structure	Type and thickness of TI in ETICS	*U* after renovation W/(m².K)		*the*	Evaluation
External wall1	EPS NEO 120 mm	**0,208**	<	**0,32** /(0,46)	**Suitable**
External wall 2	MW FKD-S 100 mm	**0,256**	<	**0,32** /(0,46)	**Suitable**
Roof	EPS 150 S 240 mm	**0,096**	<	**0,20** / (0,30)	**Suitable**
Ceiling upon not heated area	MW FKD-S 80 mm	**0,432**	<	**0,95** / (1,60)	**Suitable**
Ceiling upon the entrance	MW FKD-S 100 mm	**0,357**	<	**0,95** / (1,60)	**Suitable**



Measures: thermal insulation
windows U_g = 0,6
U_f = 1,1 W/(m².K)
glazing of loggia
heat recovery
heat pump (air-water)

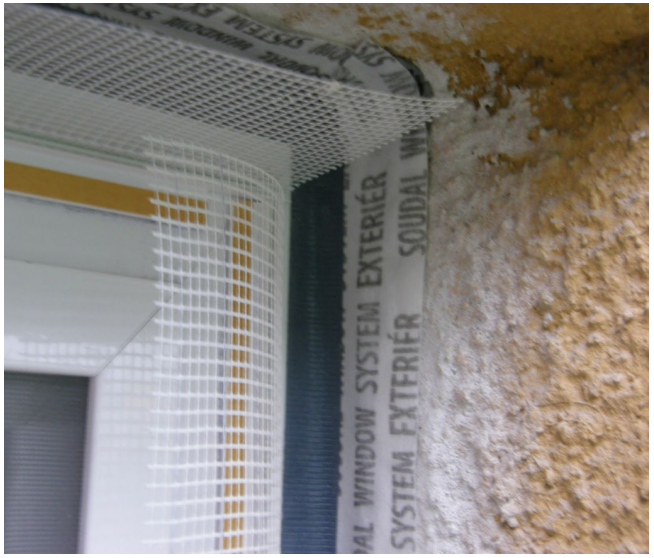


Deep renovation measures

» Measures related to the major renovation building structures

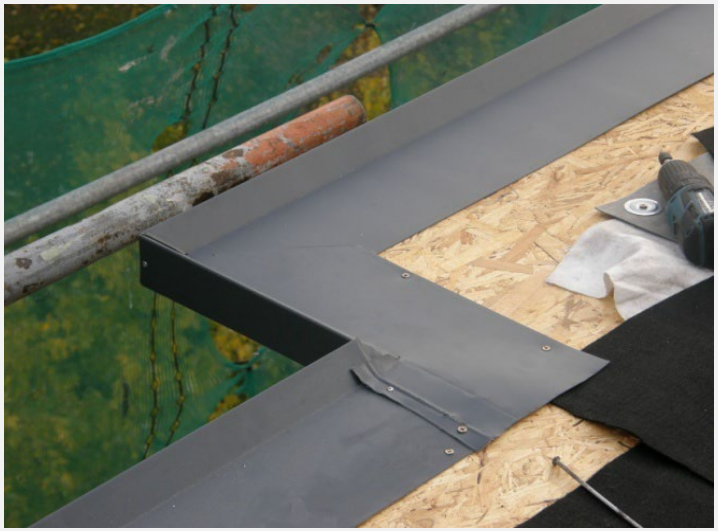
- **replacement of all windows**, for constructions with triple glazing, U_w=0.936 W/(m².K),
- installation of **decentralized controlled ventilation system with heat recovery** in every apartment,
- **thermal insulation of external walls** (with fire barriers installation,) with EPS Neopor 120 mm, U=0.208 W/(m².K) using anchors with embedded heads,
- **thermal insulation of the roof** (EPS 150 S, 240 mm, U=0.096 W/(m².K)) with increased attics and adjustment of installation structures with ventilation shafts,
- **renewal of loggias and their glazing**,
- **insulation of the ceiling above the ground floor**, mineral wool 100 mm, U=0.32 W/(m².K),
- **replacement of exterior doors, doorways and glass walls**.

Replacement of windows



Implementing heat recovery units and ETICS

Insulation of roofs



Deep renovation measures

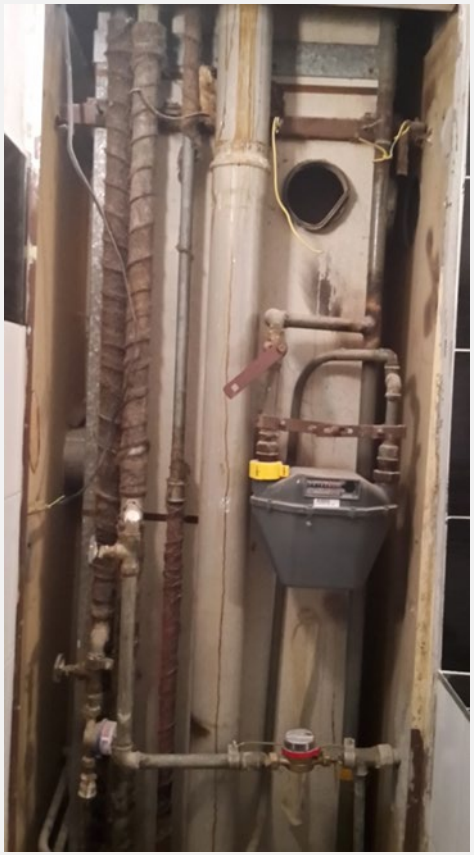
» As part of the deep renovation, restoration of technical systems of the internal distribution were carried out:

- replacement of the vertical distribution of cold water, hot water and circulation of hot water, including their insulation,
- modernization of the sewage system, horizontal and vertical installation of gas lines and exhaust air (including special arrangements for disposal of hazardous asbestos waste), replacement of exhaust fans in the bathrooms and toilets,
- disconnection from district heating (DH),
- alternative heat source: 4 in cascade connected heat pumps (air - water),
- DHW storage tanks with added electric spirals (max. 80 °C),
- 40 PV modules with 250 Wp each
- intelligent module for control and regulation of system.

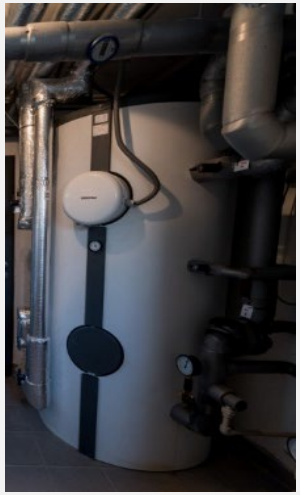
» Others – environmental requirements:

- protection of birds and bats

Flat installation cells before and after renovation




Installation of RES

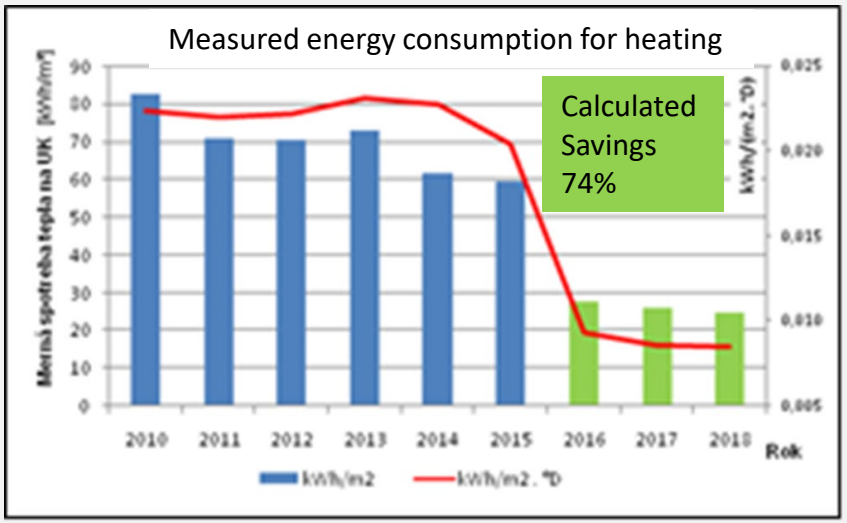


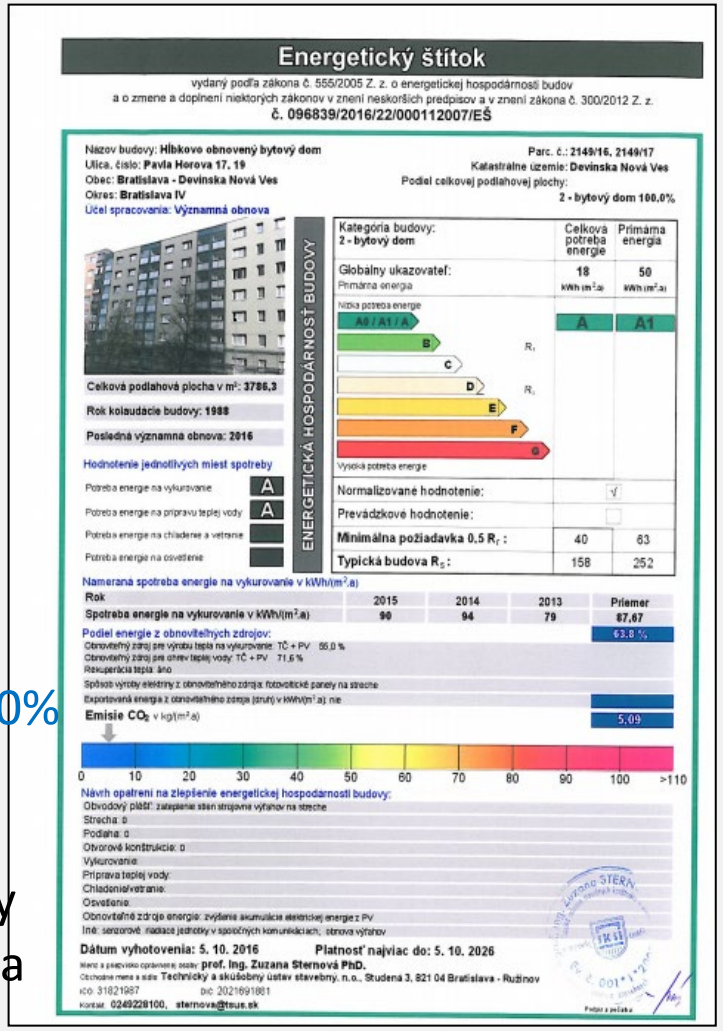
Total cost of renovation

Refurbishment costs		Financial resources	
Facades, roof, €	356 789.67	Self-financing %	7.76
Windows and doors, €	166 049.59	National subsidy %	-
Heating and ventilation, €	200 622.39	EU grant %	**20.56**
Lighting and electricity improvements, €	-	Bank loan %	71.68
TOTAL, €	**846 396.65**	Period of the bank loan, years	20 – State Fund of Development and Housing (SFRB) 15 – Bank
Planning, supervision, etc., €	71 500.00	Interest rate of the bank loan %	SFRB – 0 Bank – 2.90
VAT %	19		

The owners of the flats received a subsidy from EU GUGLE in the hight of 189 315.00 eur

Results of deep renovation





Compared to 2013, the energy consumption of the apartment building for heating was reduced by exactly 60.00% (on 0.010 kWh/degreedays – red line). The heat consumption for HDW per person per year (828 kWh) decreased by 31% compared to the average in Slovakia (1200 kWh).

Final change of view

Conclusion

From the experiences gained over the years of building renovation (since 1992) and especially from the renovation of the apartment building in Bratislava - Devinska Nova Ves (2015 to 2016), it can be stated that for the successful renovation of the building stock, it is necessary to:

- know the quality, technologies, and parameters of the building stock
- have established requirements for the thermal properties of the renovated building structures and the energy needs for individual technical systems and primary energy
- have skilled designers of building structures and technical systems
- have a network of advisors to provide information to building owners and administrators (one-stop-shop)
- create opportunities for companies providing construction services (approximately 15 professions needed for deep renovation), including education (knowledge and skills)
- ensure a system for providing financial resources (loans, grants, etc.)

Thank you for your Attention

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