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CZECH TECHNICAL UNIVERSITY IN PRAGUE

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UNIVERSITY CENTRE FOR ENERGY EFFICIENT BUILDINGS

Potential for energy savings in Czech residential building stock by application of a prefabricated mass retrofitting system

Antonín Lupíšek, Kateřina Sojková, Martin Volf, Petr Hejtmánek

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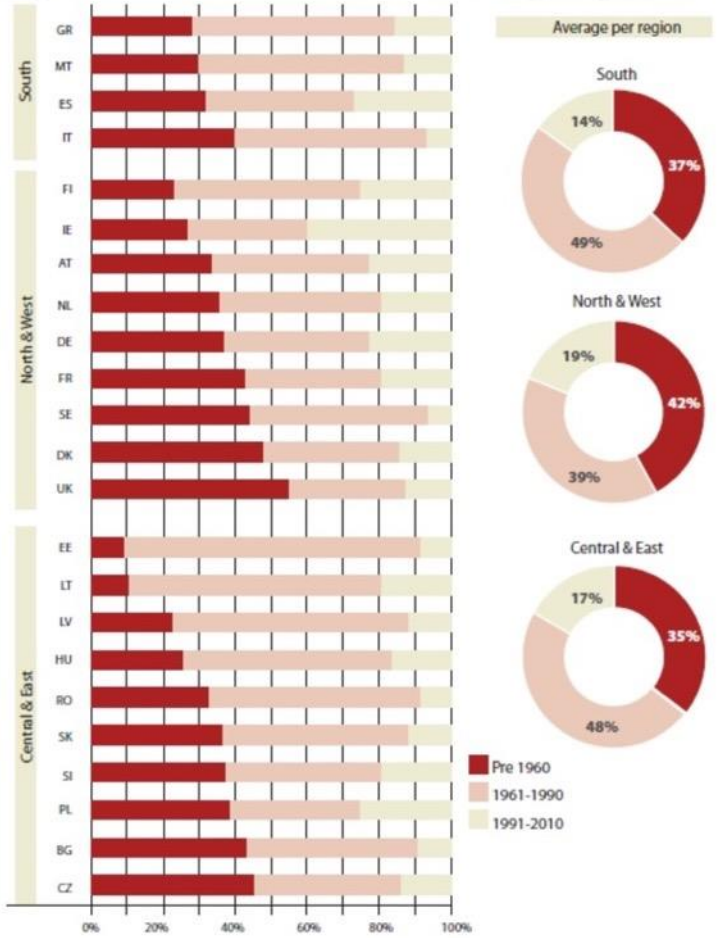
INTRODUCTION
CZECH TECHNICAL UNIVERSITY IN PRAGUE

Faculty of Civil Engineering

University Centre for Energy Efficient Buildings

BACKGROUND
EU BUILDING STOCK

Figure 2: Residential stock according to age band



Source: BPIE, 2011. Europe's Building under the Microscope: A Country-by-Country Review of the Energy Performance of Buildings

- ¾ of EU building stock = residential
- At least 80 % of EU residential buildings older than 20 years
- EU population not projected to grow
- Climate change mitigation = top priority

Energy renovation of existing building stock is urgently needed

BACKGROUND
BARRIERS TO RENOVATION

Financial barriers

- Renovation costs
- Access to finance
- Low energy prices

Technical barriers

- Lack of technical solutions
- Cost of technical solutions
- Lack of knowledge of construction professionals

Process barriers

- Fragmentation of the supply chain
- Burdening of home owners

Regulatory barriers

- Varying ambition of performance requirements
- Multiple definitions for renovation

Awareness barriers

- Lack of awareness

Buidling typology of concern

	Single Family House SFH	Terraced House TH	Multi-Family House MFH	Apartment Block AB
before 1920				
	CZ.N.SFH.01	CZ.N.TH.01	CZ.N.MFH.01	CZ.N.AB.01
1921-1945				
	CZ.N.SFH.02	CZ.N.TH.02	CZ.N.MFH.02	CZ.N.AB.02
1946-1960				
	CZ.N.SFH.03	CZ.N.TH.03	CZ.N.MFH.03	CZ.N.AB.03
1961-1980				
	CZ.N.SFH.04	CZ.N.TH.04	CZ.N.MFH.04	CZ.N.AB.04
1981-1994				
	CZ.N.SFH.05	CZ.N.TH.05	CZ.N.MFH.05	CZ.N.AB.05
after 1994				
	CZ.N.SFH.06	CZ.N.TH.06	CZ.N.MFH.06	CZ.N.AB.06

STÚ-K 2012 TABULA Project: Typology Approach for Building Stock Energy Assessment – National Scientific Report.

TYPOLOGY OF CONCERN FOR CZECHIA

260 kWh/m²a

INTORDUCTION
MORE-CONNECT PROJECT

The project developed modular renovation system enabling:

- Reduction of primary energy consumption by at least 80 %
- Variability in U-values for various climatic conditions and energy goals
- Applicability for various shapes of buildings
- Extension of existing buildings
- Integration of renewable energy system
- Improving indoor environment

MORE—
CONNECT

OBJECTIVES

- To **briefly introduce** the system designed for Czechia
- To roughly estimate the **hypothetical potential for yearly energy savings** achievable by applying the system on one typology segment of the Czech residential building stock.
  - Is it significant i.e. at least 5 % of the final energy consumption of the Czech national building stock

    or

    rather negligible i.e. below 1 % of the final energy consumption of the Czech national building stock?

METHODS

- Description of the modular renovation system
- Analysis of the building typology of concern
- Case study of the achievable savings on a typical building
- Validation with other work
- Extrapolation to relevant building stock
- Calculation of CO_2 emissions savings

VARIABILITY

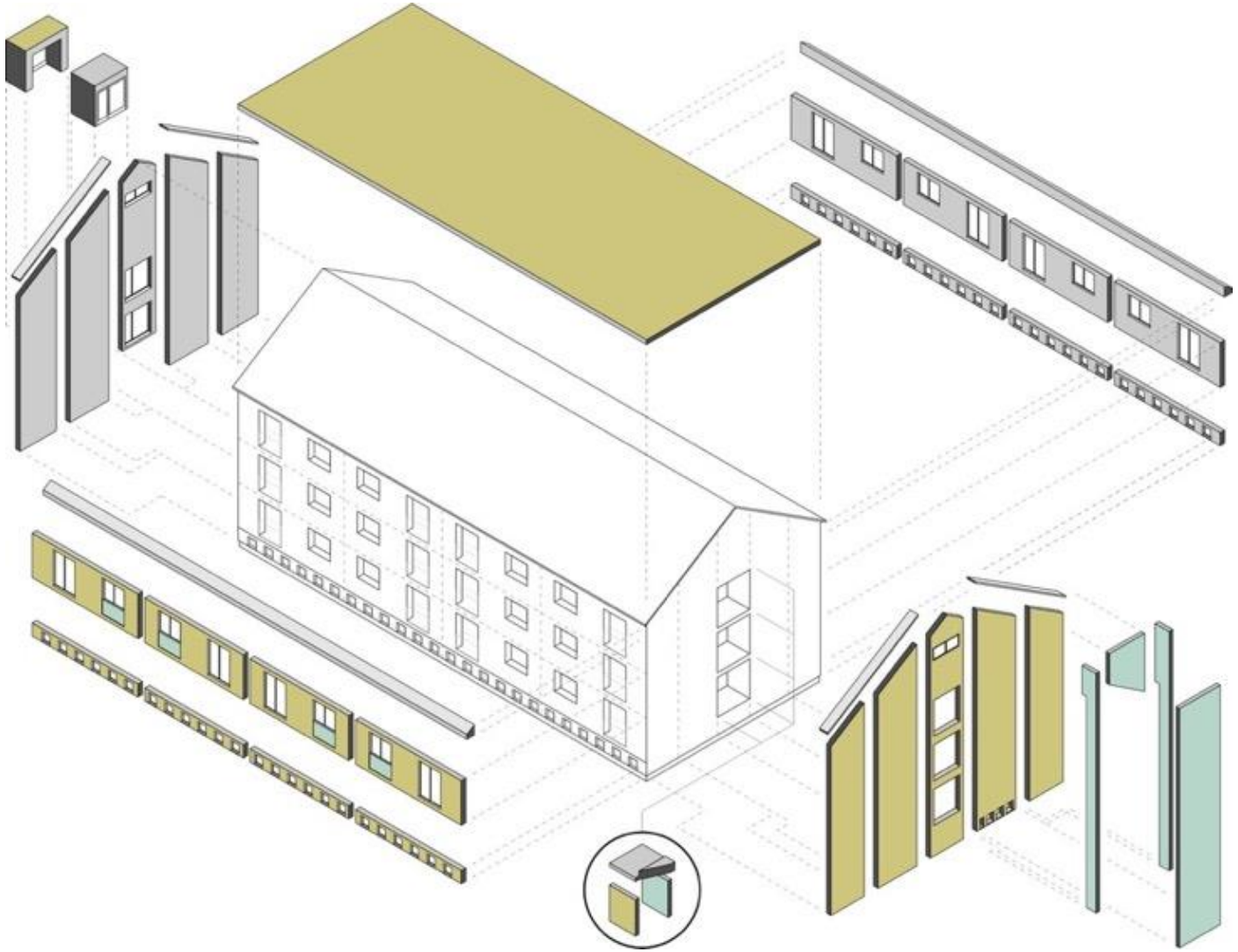
LOW-COST
- only ZEB required installations

ECO-ECO
- ZEB building
- separate flats in attic

HI-TECH
- ZEB building
- maisonettes in attic
- advanced technologies

Also lower cost variants with worse parametres possible

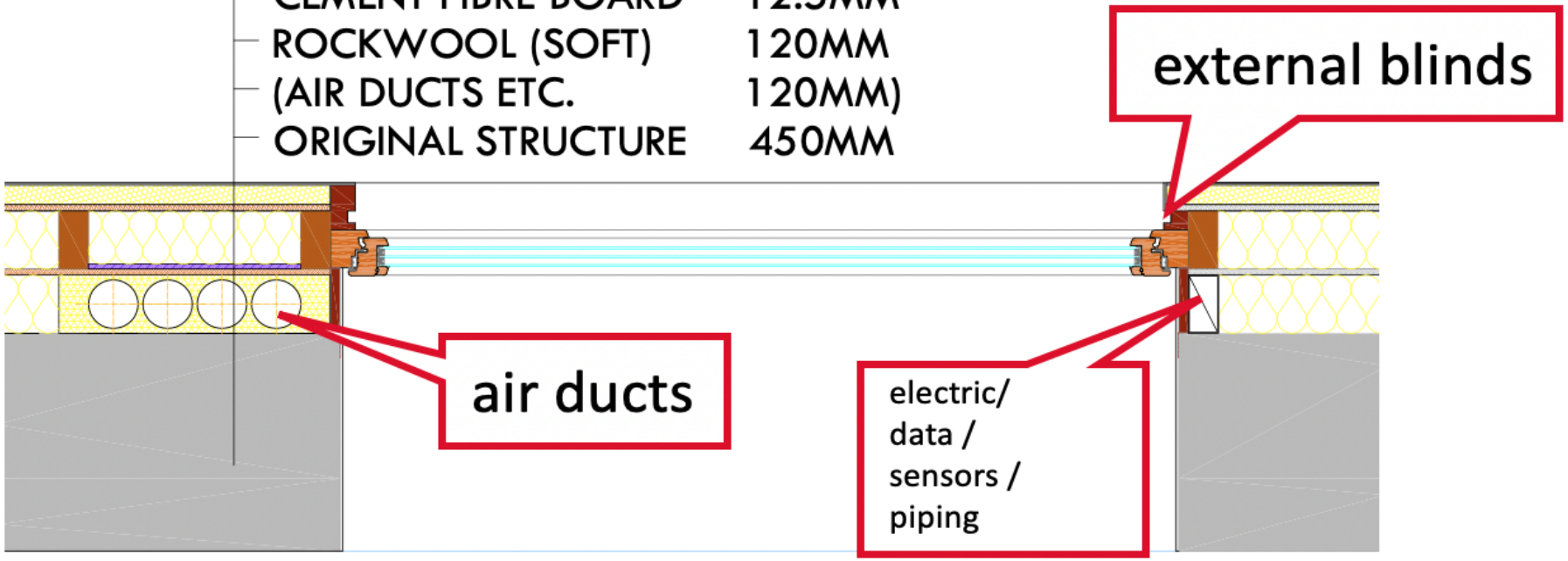
THE CONSTRUCTION SYSTEM



WALL MODULE – COMPOSITION

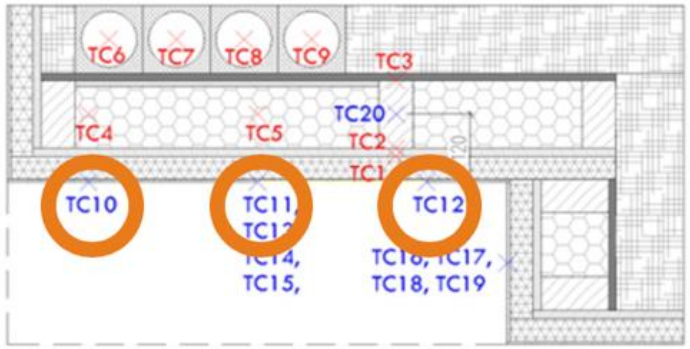
Ventilation
Heating
Electric/data installations

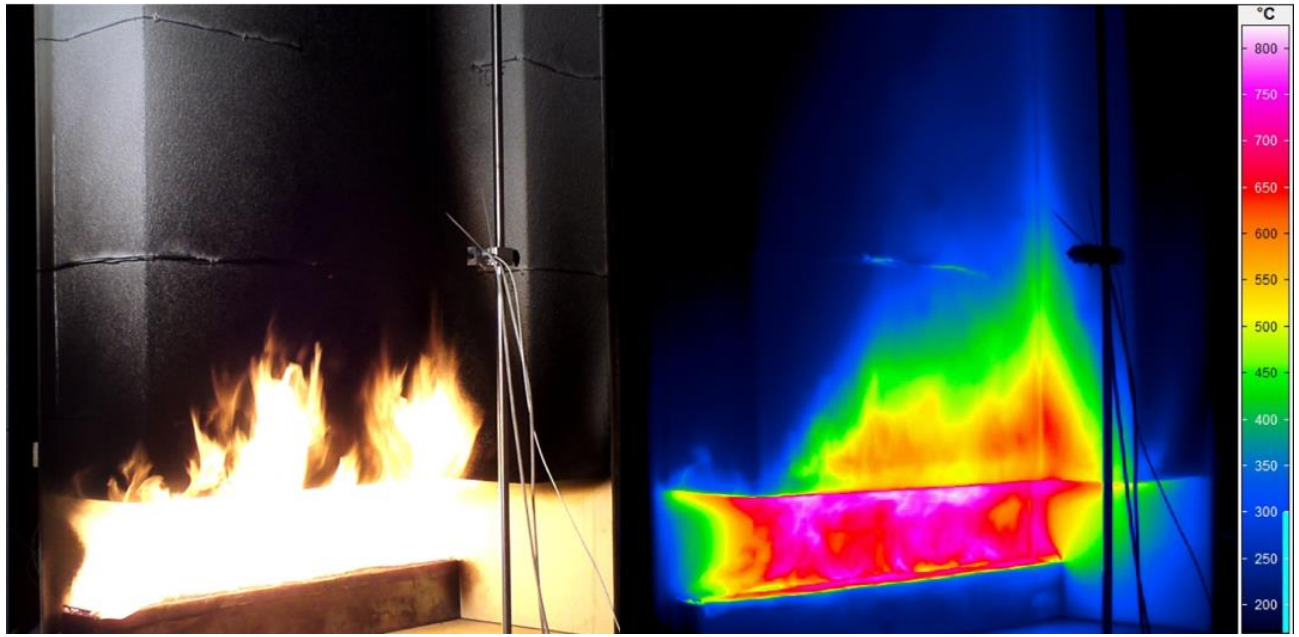
PLASTER	5MM
ROCKWOOL (RIGID)	40MM
WOOD FIBRE BOARD	13MM
WOODEN POSTS	60/120MM
ROCKWOOL	120MM
VACUUM INSULATION	10MM
CEMENT FIBRE BOARD	12.5MM
ROCKWOOL (SOFT)	120MM
(AIR DUCTS ETC.	120MM)
ORIGINAL STRUCTURE	450MM

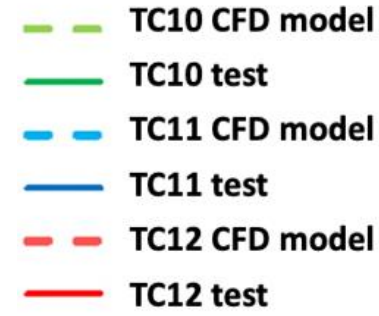


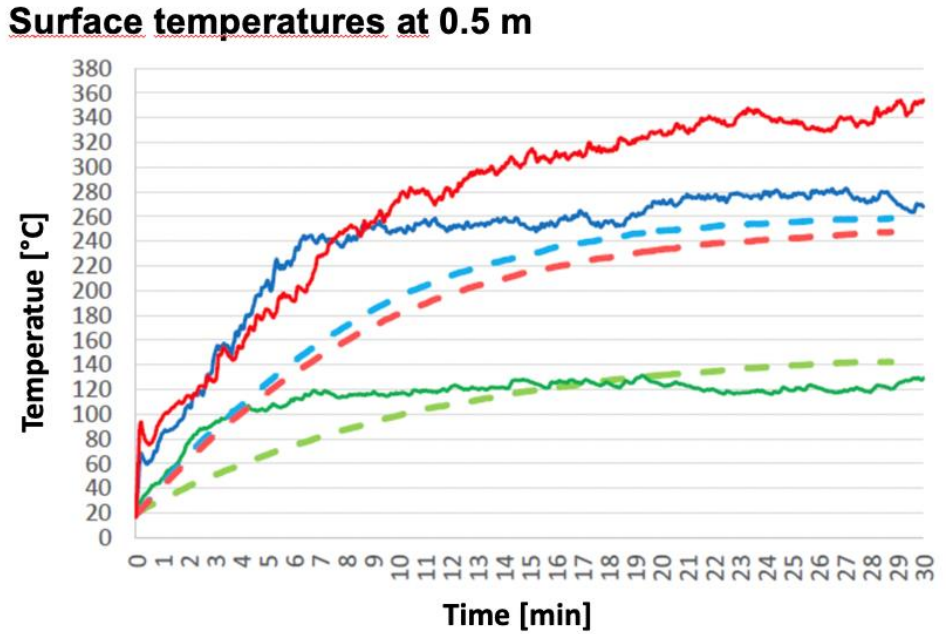
PROTOTYPING
WALL-WALL MODULES ASSEMBLY

FIRE MODELLING AND TESTING

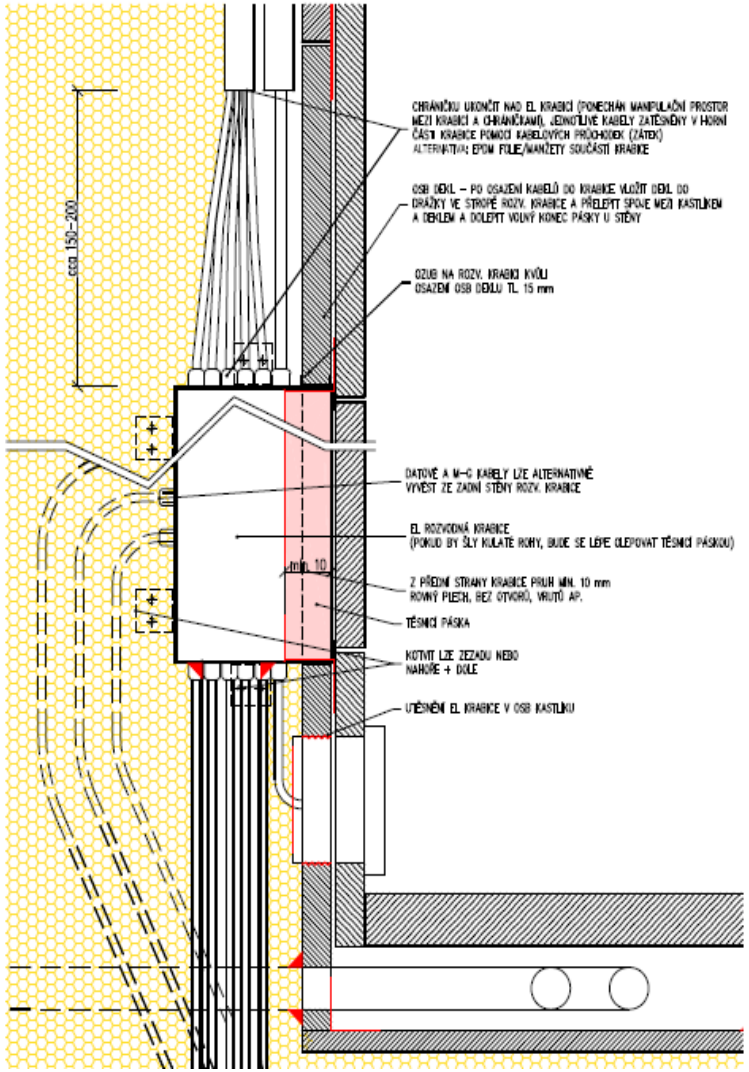








PROTOTYPING MODULE-WALL-WINDOW-TECHNOLOGY



TEST OF CRITICAL DETAILS ASSEMBLY

SEMI-AUTOMATED LINEAR PRODUCTION OF MODULES

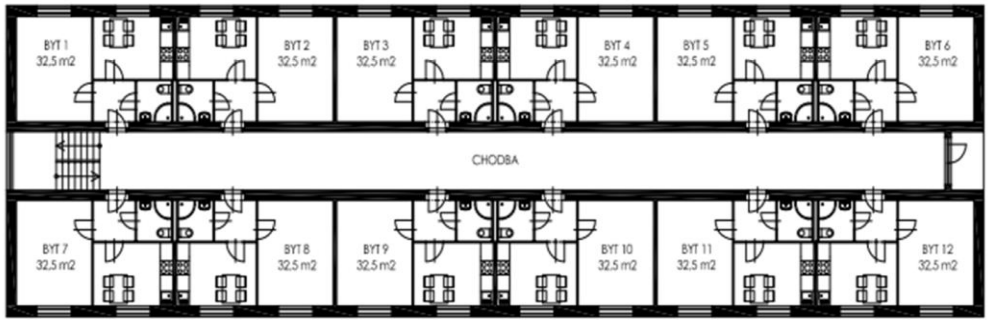
RD RÝMAŘOV

ASSEMBLY

ASSEMBLY

ASSEMBLY FINISHED

THE CASE STUDY
MILEVSKO, CZECHIA



- Social housing, built in 1958
- Lateral masonry bearing system
- 3 floors + basememt, pitched roof (33°)
- 24 similar flats with area of 32.5 m^2 each
- 995 m^2 usable floor area
- 1,107m^2 energy related area
- New roof, plastic windows U=1.2, otherwise untouched since construction
- U: wall 1.4, attic floor 0.9, ceiling 2.2 W/m^2K
- Simulated specific energy consumption 230 kWh/m^2a for heating

MODELED IMPROVEMENTS

- Derived cost-optimum variants of the renovation package [1]
- Thermal insulation modules incl. new windows – mean U-value reduced to 0.25 W/(m2·K)
- Central mechanical ventilation with heat recovery
- Total energy consumption can be decreased to 33–90 kWh/(m2·a), which corresponds to specific energy consumption for heating between 25–41 kWh/(m2·a) (89–82% savings).
- Expressed as specific energy saving potential, retrofitting using MORE-CONNECT solution can **save 251 kWh/(m2·a) from total energy consumption in average** (up to 285 kWh/(m2·a) at maximum).

[1] Sojková K, Volf M, Lupíšek A, Novák E and Váchal T 2018 MORE-CONNECT – Final selection of favourable concept based on LCA.

IDENTIFICATION OF AVAILABLE BUILDING STOCK


ŠANCE
PRO BUDOVY

Zakládající partneři

PRŮZKUM FONDU REZIDENČNÍCH
BUDOV V ČESKÉ REPUBLICE
A MOŽNOSTÍ ÚSPOR V NICH

Rešerše stávajících studií a výpočtové ověření pro rezidenční budovy

Aktualizovaná verze, prosinec 2016

Ing. Jan Antonín, Ph.D., za přispění týmu Šance pro budovy

CENTRUM PASIVNÍHO DOMU

Významní partneři

Partner

Publikace byla zpracována za finanční podpory Státního programu na podporu úspor energie a využití obnovitelných zdrojů energie pro – Program EFEKT.

EFEKT energie efektivně

MINISTERSTVO PRŮMYSLU A OBCHODU

Šance pro budovy je aliance významných oborových asociací podporující energeticky úsporné stavebnictví. Sdružuje **Centrum pasivního domu**, **Českou radu pro šetrné budovy**, **Sdružení EPS**, **Asociaci výrobců minerální izolace** a **Asociaci poskytovatelů energetických služeb.** Reprezentuje přes 300 firem napříč hodnotovým řetězcem výstavby a renovace budov. Šance pro budovy usiluje o dosažení mnohočetných společenských přínosů, které s sebou energeticky úsporné budovy nesou.

info@sanceprobudovy.cz www.sanceprobudovy.cz

- Total gross floor area of the Czech multi-family residential building stock built between 1946 and 1960 is approx. 15,657,000 m^2 [4]
- The developed solution has limitation given by the national fire safety regulations, which forbid combustible products to be used in the envelopes of buildings with “fire height” above 12.0 m (i.e. distance between first and the upmost flooring). The regulation reduces the applicable gross floor area to 10,926,000 m^2
- 35 % of the Czech residential buildings have already been renovated, remaining gross floor area available for retrofitting has to be reduced to **7,101,900 m^2**

RESULTS – ENERGY

- Total national energy consumption in buildings: 96,944 GWh (62,222 GWh res.)
- Maximum potential of energy savings 1,783 GWh/a

  which represents 1.8 % of the national energy consumption in buildings

  (2.9 % of residential buildings)
- 1 % < **1.8 %** < 5 % … not bad

[1] Šance pro budovy 2016 Strategie renovace budov – aktualizace prosinec 2016, doplněná o strategii adaptace budov na změnu klimatu

RESULTS – CO_2

- Total CO_2 emissions from national bldg. stock 44.57 Mt, residential 23.38 Mt in 2016 [1]
- Emission factor of Czech bldg. stock approx. 376 t CO_2/GWh [1, 2]
- 376 x 1,783 GWh = **670 kt CO_2**
- **1.5 %** of national bldg. stock emissions (2.9 % of residential bldg. stock)

[1] Šance pro budovy 2016 Strategie renovace budov – aktualizace prosinec 2016, doplněná o strategii adaptace budov na změnu klimatu

[2] A Lupíšek 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **290** 012101

CONCLUSIONS

- Developed a complex renovation system based on timber frame panels that enables prefabrication, significantly speeding-up the onsite works without need of scaffolding,
- The results of the calculation showed, that the potential for savings in the energy consumption of the residential buildings is 1,783 GWh/a, which represents 1.8% saving on the total national energy consumption and 1.5 % CO_2 emissions in buildings
- The result is not significant, but not negligible.
- In process of founding of university spin-off company to bring the product to market

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Thank you for attention.

antonin.lupisek@cvut.cz