City of Belgrade, residential building fund, energy performance, improvement possibilities.

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City of Belgrade

1,659,440

Source: Statistical Office of the Republic of Serbia
City of Belgrade

Constructed flats by periods
Total 734,909 flats, 48,620,227 m²
Average flat size 63.44 m²

Source: Statistical Office of the Republic of Serbia
City of Belgrade

City area 322.268 ha
Inner city area 35.996 ha

Source: Google earth
City of Belgrade

Source: Google earth
City of Belgrade

New Belgrade

Source: Google earth
City of Belgrade

Outer city

Source: Google earth
City of Belgrade – building fund

Main questions:

• How does the building fund of Belgrade look like?
• What are material characteristics of buildings?
• What is the current state (level of deterioration) of the buildings?
• How much energy buildings consume (in total)?
• What is the potential for improvement?
• How can we estimate the potential investment?
• What are the possible savings in energy and CO2?
• ...
City of Belgrade – building fund

Expert estimation of building fund multifamily buildings


Energy optimization of buildings in context of sustainable architecture - part 1, Belgrade, Faculty of Architecture, (in Serbian)
City of Belgrade - Building fund

Awareness campaign 2010-2011.

Source: Faculty of Architecture, exhibition material
City of Belgrade - Building fund

“IR Atlas of Belgrade”
Research project,
Faculty of Architecture,
Supported by
2010-2012.

Expert analysis of 32 representative Building types
(30 multifamily and 2 single family)
• Performance calculation
• Improvement potential calculation
• Investment and payback calculation

Atlas of Belgrade buildings envelope energy characteristics,
Belgrade, Faculty of Architecture, project report (in Serbian)
National typology of Residential buildings in Serbia - Building fund

Research project - National level
EU TABULA* project, Serbia only non EU participant
Faculty of Architecture
Supported by 2011-2013.

Census of 22 000 buildings
Development of methodology
Identification of model buildings
Calculation of performance (new regulations)
Improvement potential
Energy and CO² savings potential


Source: Јовановић Поповић М., Игњатовић Д. (ур), (2013). National Typology of Residential Buildings in Serbia, Београд: Архитектонски факултет
National vs. Local typology of Residential buildings

Problem of local relevance and implementation possibilities of methodology developed for the National typology

Implementation on the particular building type level
Improvement by packages as defined by TABULA project
No financial aspect of refurbishment analyzed

Municipal level implementation depends on the local building fund characteristics
Need for estimation of single measure impact
Need for estimation of investments and pay back
Building fund of City of Belgrade – performance levels

What are material and energy performance levels of Belgrade buildings?

Calculated consumption: \( Q_{h, nd} = 252 \text{ [kWh/m}^2\text{a]} \), upper floor not heated

Building fund of City of Belgrade – performance levels

What are material and energy performance levels of Belgrade buildings?

Calculated consumption: \( Q_{h, nd} = 172 \text{ [kWh/m}^2\text{a]} \), Some flats not heated

Building fund of City of Belgrade – performance levels

Performance? Individual initiative

Source: Јовановић Поповић М., Игњатовић Д. (ур), (2013). National Typology of Residential Buildings in Serbia, Београд: Архитектонски факултет
City of Belgrade – Conserve energy

Based on “IR Atlas of Belgrade”

Expert analysis of 10 representative building types – multifamily

Supported by

• Performance calculation – new regulations
• Improvement potential calculation – single measure and package of measures impact
• Investment and payback calculation

10 steps to refurbishment

Source: Ignjatović, D. Ćuković-Ignjatović, N. Conserve energy, working material
City of Belgrade – Conserve energy – example

Building 02

Number of floors: B+GF+5
Construction year: 1953.
Gross area: 4180m²
Heated area: 2182m²
National typology type: C4
TABULA type: 3_AB

Source: Ignjatović, D. Ćuković Ignjatović, N. Conserve energy, working material
City of Belgrade – Conserve energy

Facade segment 2: Original segment of thermally non-insulated facade
Сегмент фасаде 2: Сегмент оригиналне термички неизоловане фасаде

Typical segment of masonry facade wall constructed without thermal insulation. Reinforced concrete ring beams and window lintels are zones of the wall that are characterized by highest thermal losses, on thermogram, with temperature difference of almost 3°C compared to masonry infill. Thermogram also illustrates that building has been constructed without vertical reinforcements.

Карактеристични сегмент фасаде зиданих објеката без термоизолације. Термограм илуструје изразите зоне у зонама хоризонталних армирано-бетонских елемента и направних греда са температурним разликом од 3°C у поређењу са зидним делом. На термограму се може уочити да објекат нема вертикале армирано-бетонске елементе.

Source: Ignjatović, D. Ćuković Ignjatović, N. „Conserve energy“, working material
City of Belgrade – Conserve energy
City of Belgrade – Conserve energy

Source: Ignjatović, D. Ćuković Ignjatović, N. „Conserve energy“, working material
City of Belgrade – Conserve energy

Current state $Q_{h, nd} = 162.08$ [kWh/m$^2$a],

Improved state $Q_{h, nd} = 77.91$ [kWh/m$^2$a],

Source: Ignjatović, D. Ćuković Ignjatović, N. „Conserve energy“, working material
City of Belgrade – Conserve energy – summary

Source: Ignjatović, D. Ćuković Ignjatović, N. „Conserve energy”, working material
City of Belgrade – needed next steps

Building fund:
Belgrade building fund – Typology
Other building typologies (educational, health, public, administrative...)

Refurbishment process:
Procedures explained – manual and guidebook
Financial modalities and support for improvement (funding)

Pilot projects:
Illustrative projects with good practice case explained
Pre and post refurbishment monitoring
Thank you for the attention

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