Energy savings potential of the e-SAFE project renovation solutions

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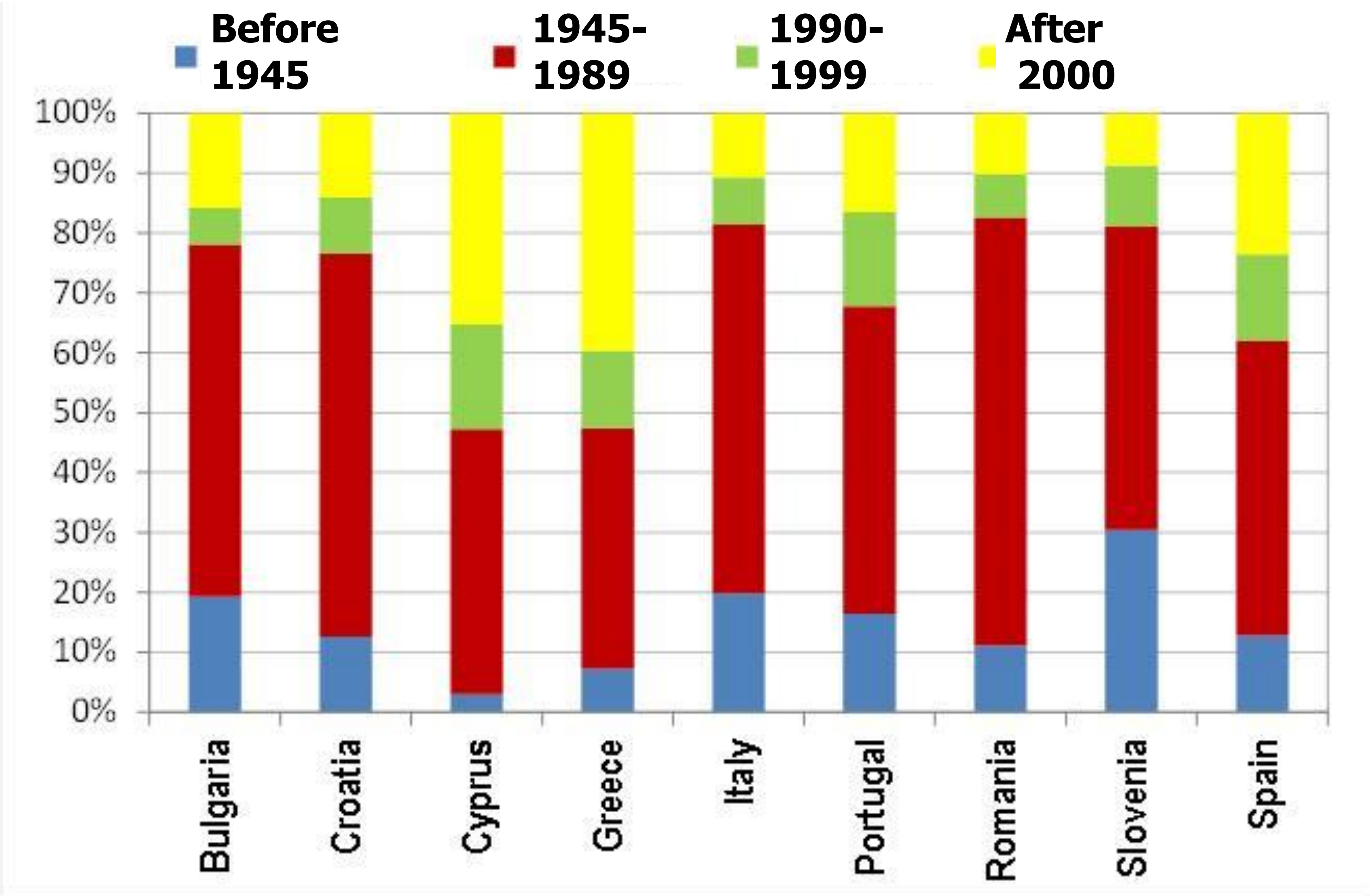
e-SAFE has received funding from the European Union's Horizon 2020. Coordination and support action programme under grant agreement No 893135.

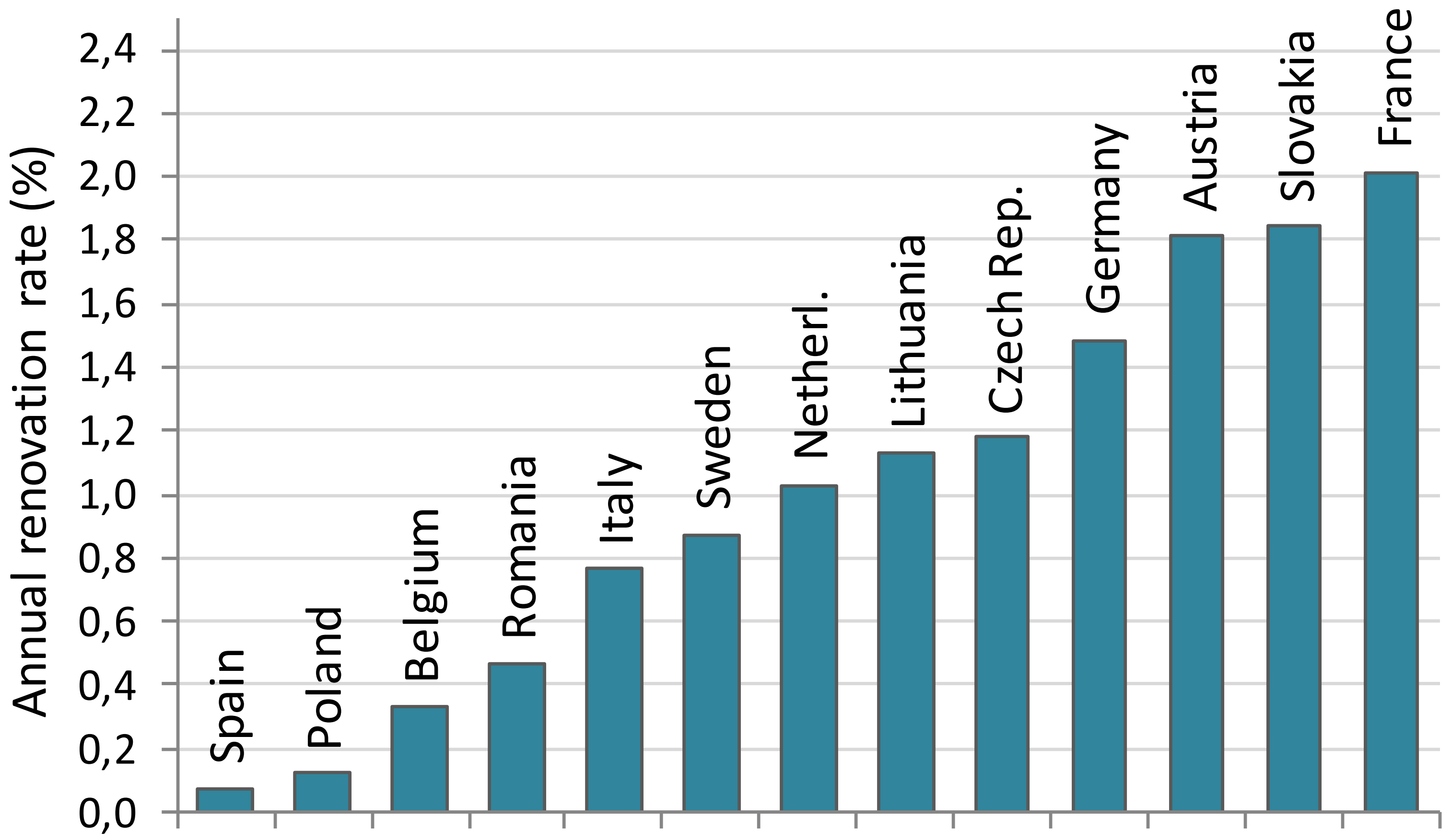
Background

Deep energy renovation of the EU building stock

- The building sector is responsible for 40% of EU final energy demand and for 36% of GHG emissions
- EU target: cut GHG emissions by 40% in 2030 and by 100% in 2050, compared to 1990 levels



Distribution of EU residential buildings by **construction period**



The building **renovation rate** is still highly **unsatisfactory**, since it hardly exceeds 1.2% on average

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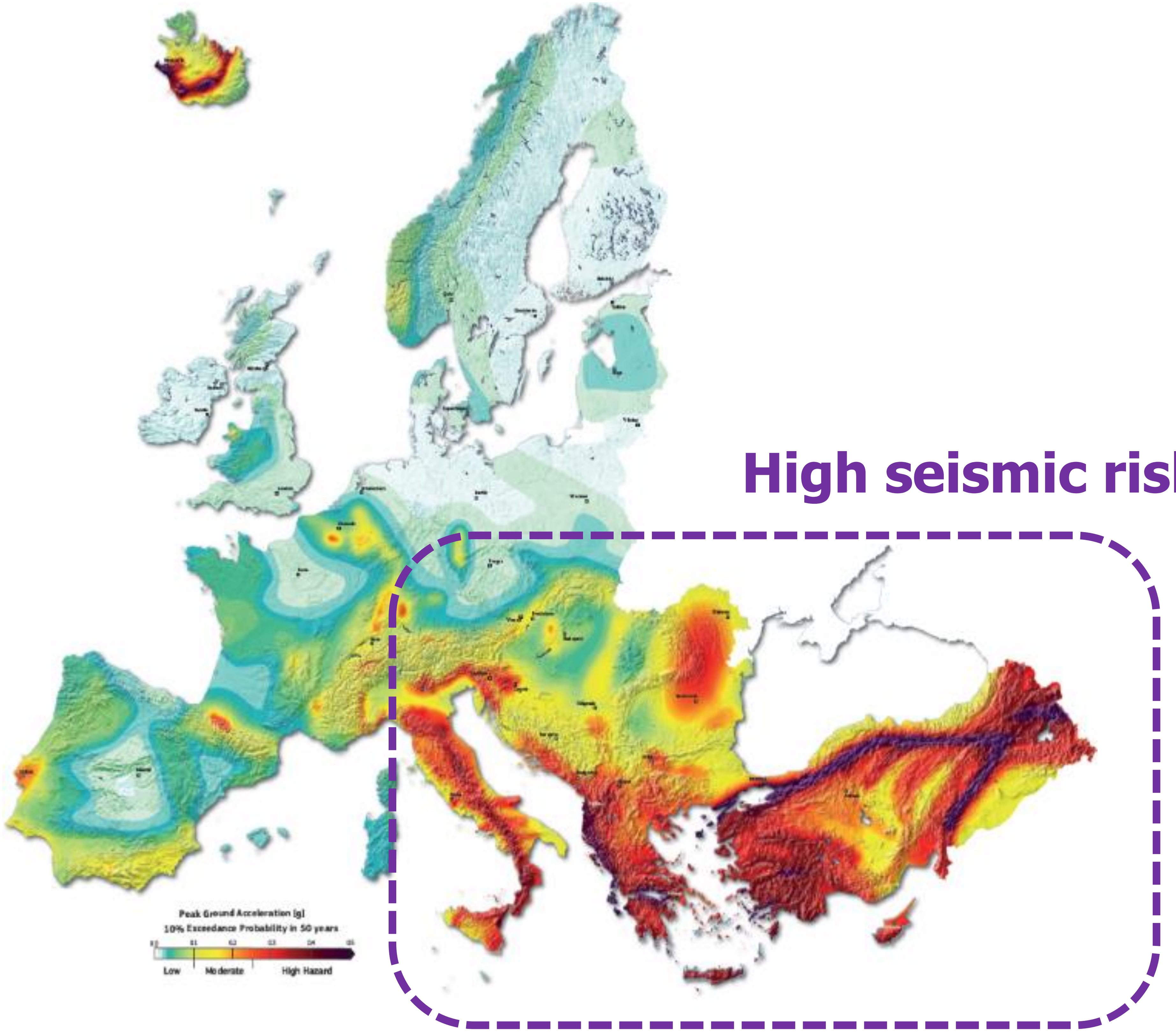
Background

Seismic retrofit of the EU building stock

High seismic risk



Furthermore, about **50%**
of the European territory **is earthquake-prone**

In the last **50 years**, in Europe, earthquakes have caused:

- over 36.000 deaths
- around 1.4 million homeless

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The e-SAFE project

Energy and seismic retrofit of the EU building stock

The EU-funded H2020 innovation Project called **e-SAFE** (energy and Seismic Affordable rEnovation solutions) has started in October 2020 and will end in October 2024

The project is developing and demonstrating new technical solutions for the energy and seismic deep renovation of non-historical reinforced-concrete (RC) framed buildings

e-SAFE

http://esafe-buildings.eu/en/

The Consortium partners are from **eight EU Countries** selected from different climate zones, and including highly seismic regions

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e-SAFE

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The e-SAFE project

Energy and seismic retrofit of the EU building stock

- Minimize time for renovation works
- Demonstration
- Training professionals
- Technological development
- Architectural improvement
- Social issues
- Minimize disruption
- Minimize costs
- Financial tools

e-SAFE

The synergy of all these manifold aspects is expected to overcome the **barriers towards full market uptake**

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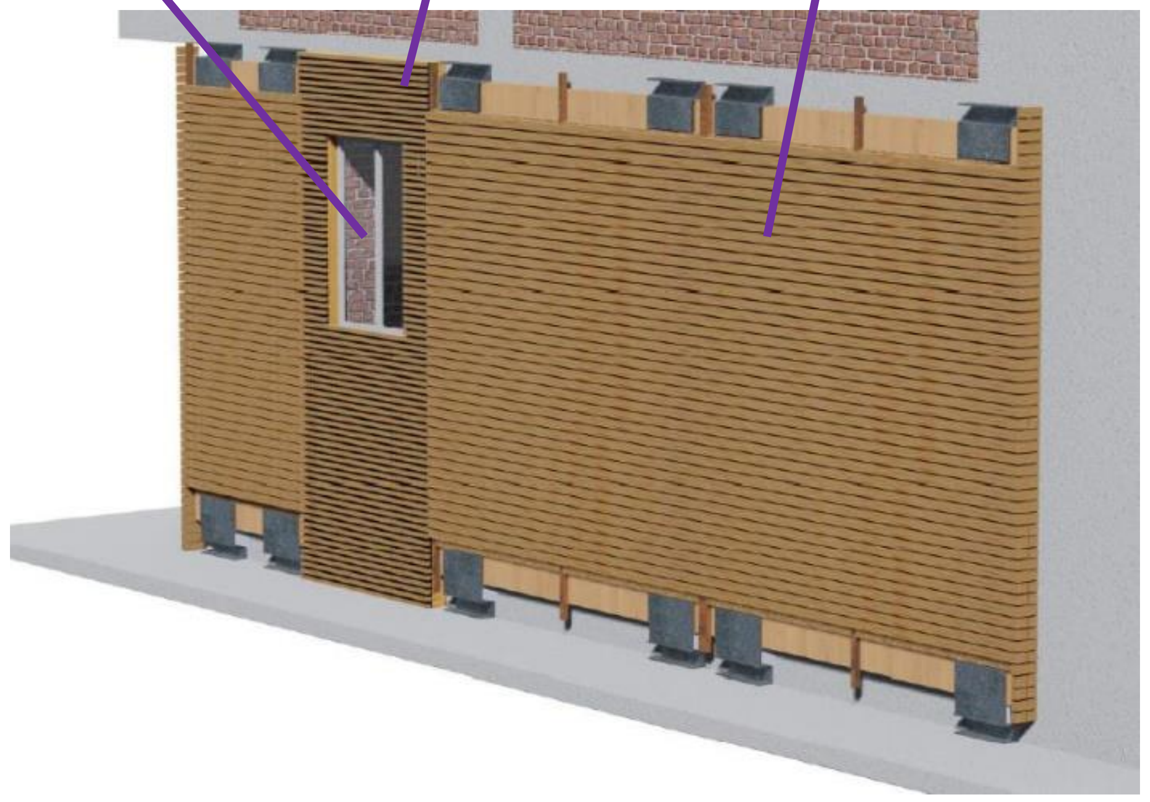
The e-SAFE concept

A new building skin



e-PANEL: prefabricated plug-and-play modules with timber-framed structure and bio-based insulation

e-CLT: structural panels made of Cross Laminated Timber, which increase seismic performance through their connection to the existing RC beams with specifically designed friction dampers.

e-EXOS: exoskeleton with metal bracings and seismic dampers (alternative to CLT for seismic areas)

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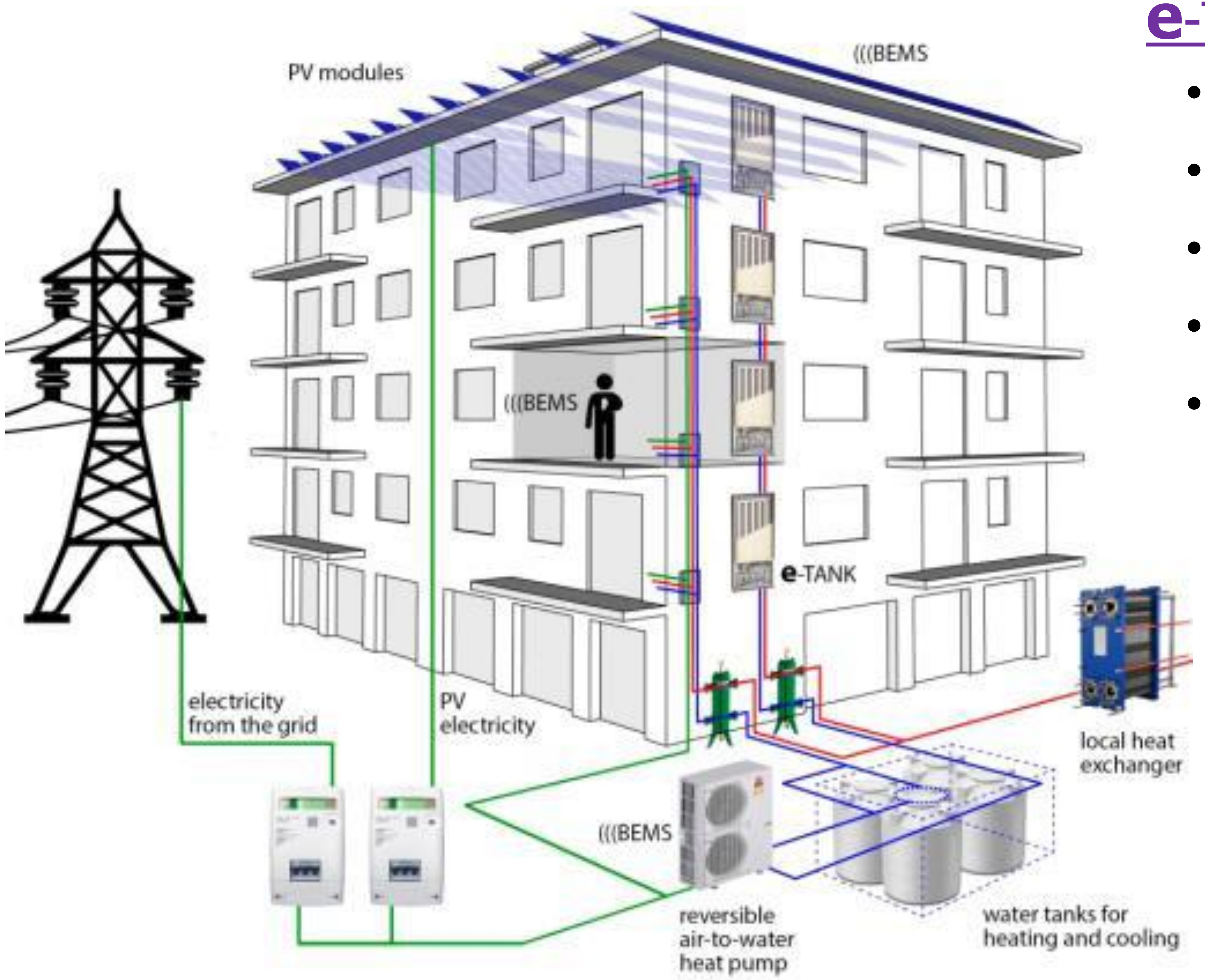
Technical systems for minimum energy demand



e-THERM:

- High-performance air-to-water electric heat pumps
- Insulated water tanks to store thermal energy
- Full DC inverter technology
- Refrigerants with low GWP will be preferred.
- Fan coils fed at low/medium temperature (< 45 °C)

e-TANK:

Small storage tanks for DHW (140 litres)

Plug-and-play hydraulic connections

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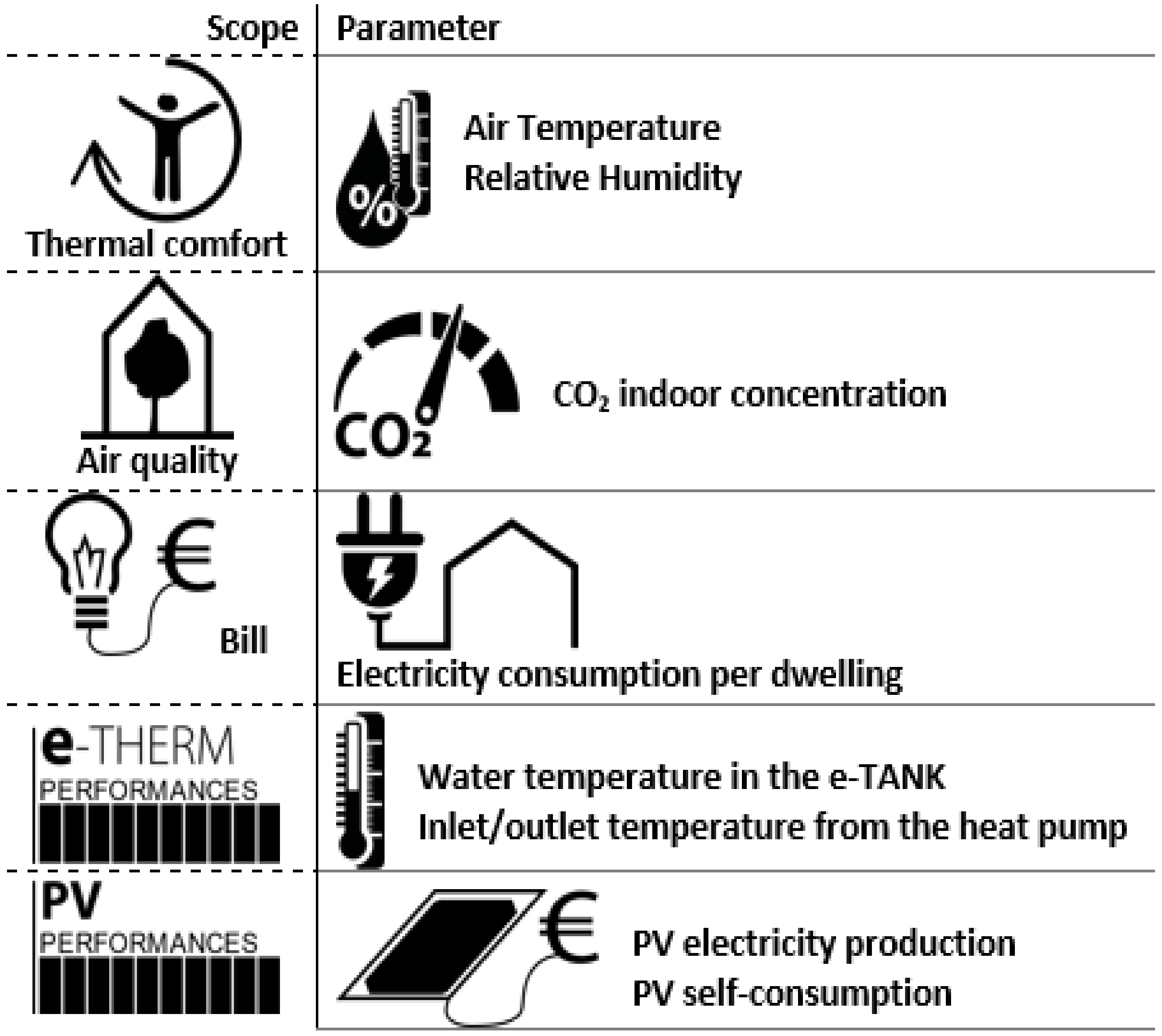
Building Energy Management System (BEMS)

Building Energy Management System (e-BEMS)

- Monitoring indoor temperature, relative humidity and CO_2 concentration
- Monitoring the energy consumption
- Displaying information on a smartphone application
- Suggesting suitable actions to reduce energy needs and to improve thermal comfort and air quality
- Managing the operation of the heat pump and the storage tanks to maximize the self-consumption rate



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The e-SAFE concept

Demonstration activities: real and virtual pilot buildings

- The demonstration of the e-SAFE renovation solutions takes place through different **pilot buildings**, for which a detailed design activity (to execution drawing level) is carried out

A residential building in Catania (Italy) where every technology will be actually installed (**REAL PILOT BUILDING**)

A school and a residential building in Romania where the effectiveness of the technologies is tested through numerical analyses only (**VIRTUAL PILOT BUILDINGS**)

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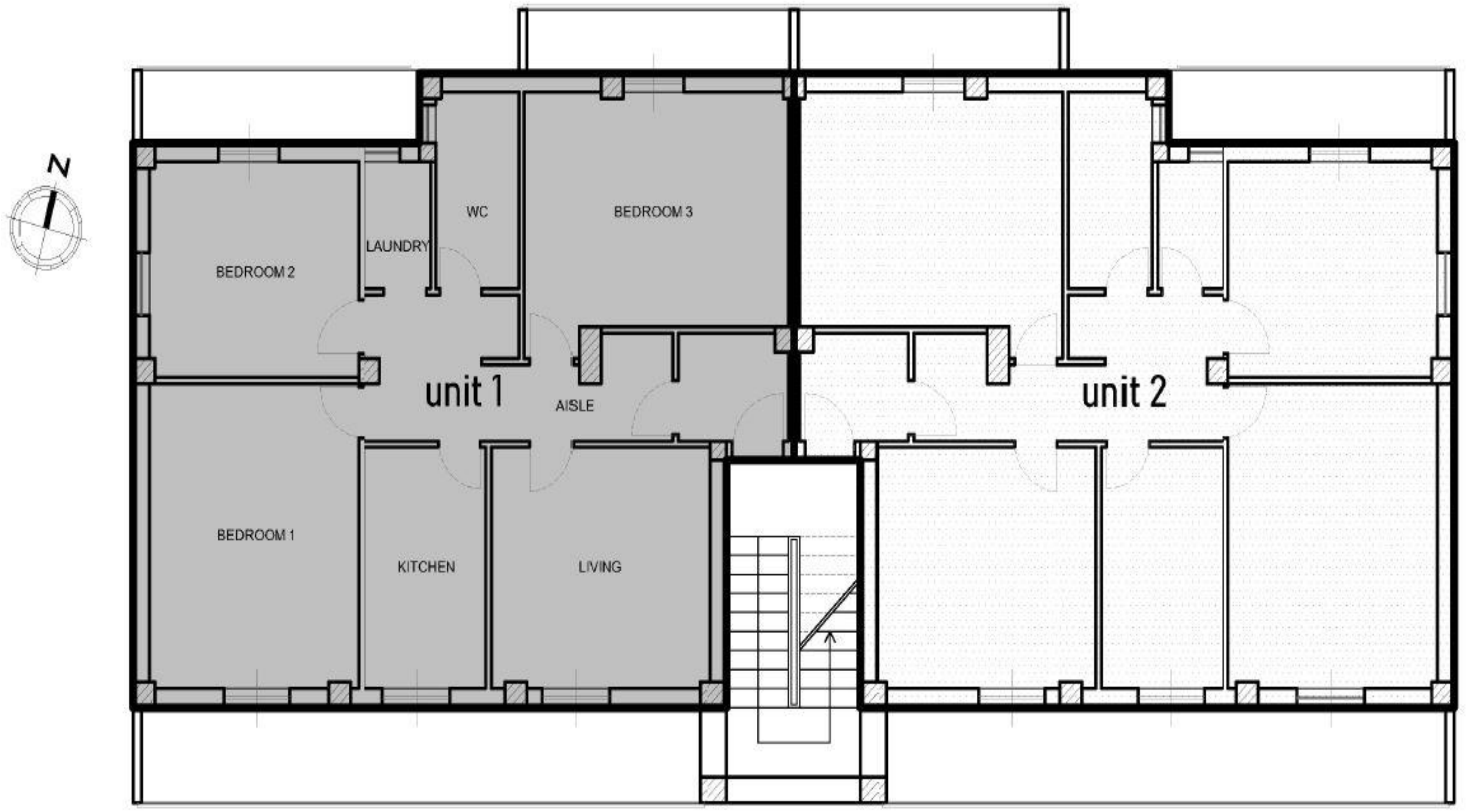
Demonstration activities: the real pilot building in Catania



One **residential building** located in Catania (Southern Italy) and owned by the Italian **Social Housing Institute** (IACP)

- Built in the 1960s (never renovated)
- Gross floor area: about 1200 m^2
- RC frame and two leaves of hollow clay bricks – current U_{walls} = 1.0 W/(m^2K)
- Lightweight concrete slab – current U_{roof} = 1.2 W/(m^2K)
- Single-glazed metallic frame windows – current $U_{windows}$ = 2.7 – 6.0 W/(m^2K)
- Some boilers and electric heaters for providing DHW and space heating
- Some split units for providing space cooling

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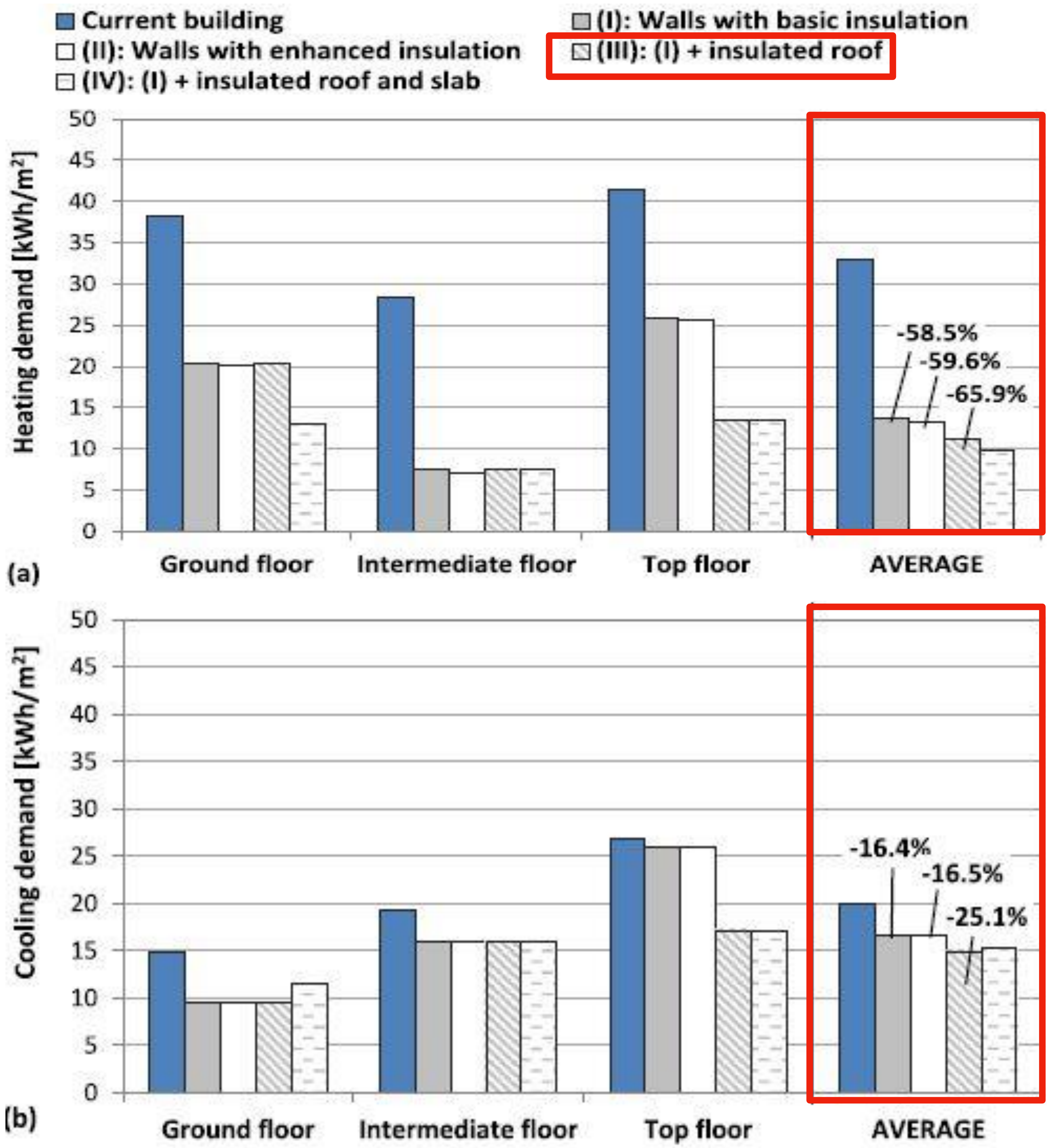
Demonstration activities: the real pilot building in Catania



- Dynamic thermal simulations performed with detailed occupancy schedules (from onsite surveys with occupants)
- Energy savings for space cooling are less evident than those for space heating
- **Retrofit scenario III** (walls insulation + roof insulation) **is the most cost-effective**

PRIMARY ENERGY SAVINGS 85-95%

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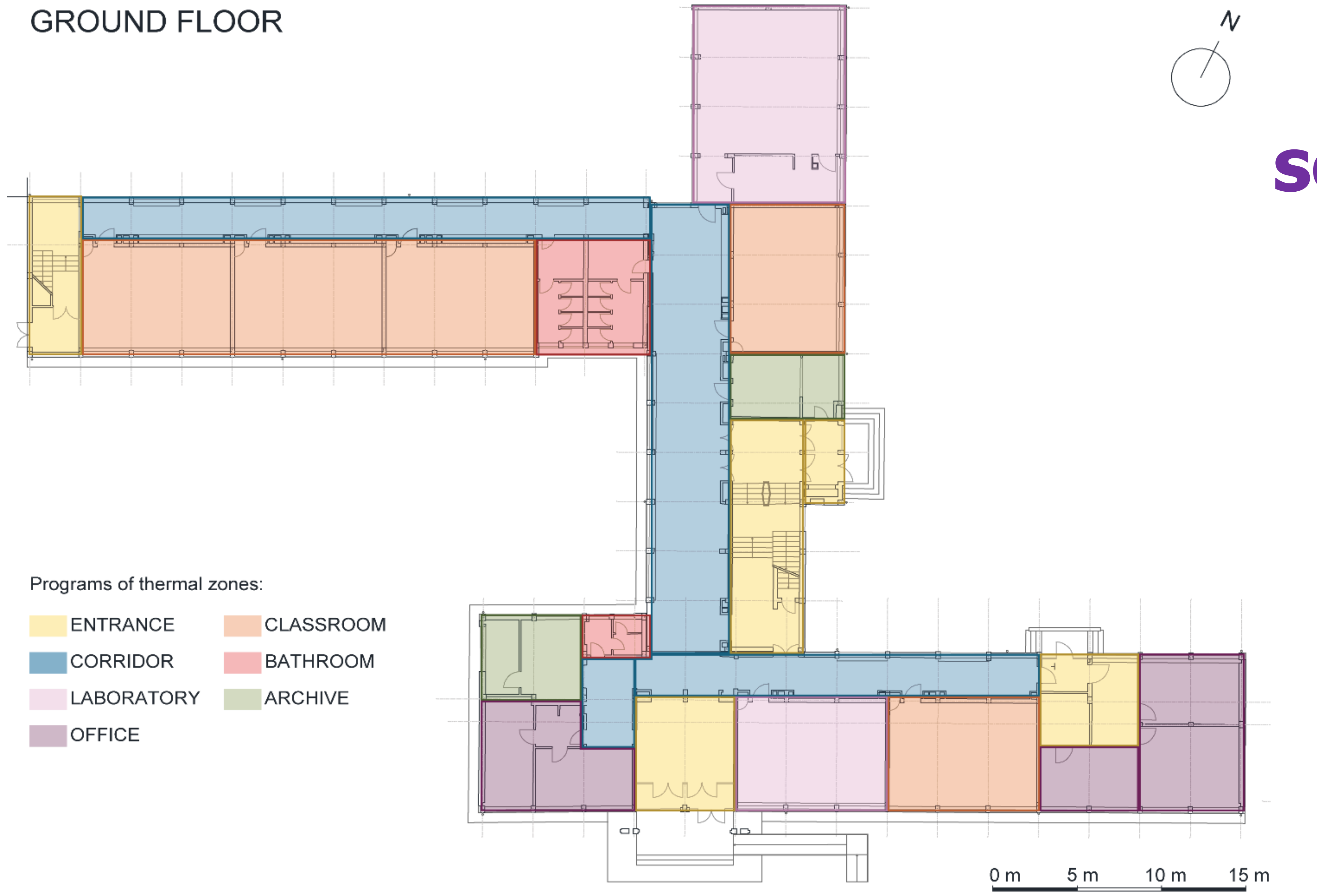
The e-SAFE concept

Demonstration activities: the virtual pilot building in Timisoara



One **public school building** located in Timisoara (Western Romania)

- Built in the 1950s and renovated in 2006
- Gross floor area: about 3700 m^2
- RC frame and solid brick masonry – current $U_{walls} = 1.4\ W/(m^2K)$
- Reinforced concrete slab – current $U_{roof} = 3.1\ W/(m^2K)$
- Double-glazed PVC frame windows – current $U_{windows} = 2.7\ W/(m^2K)$
- District heating and radiators for providing DHW and space heating
- Some split units for providing space cooling

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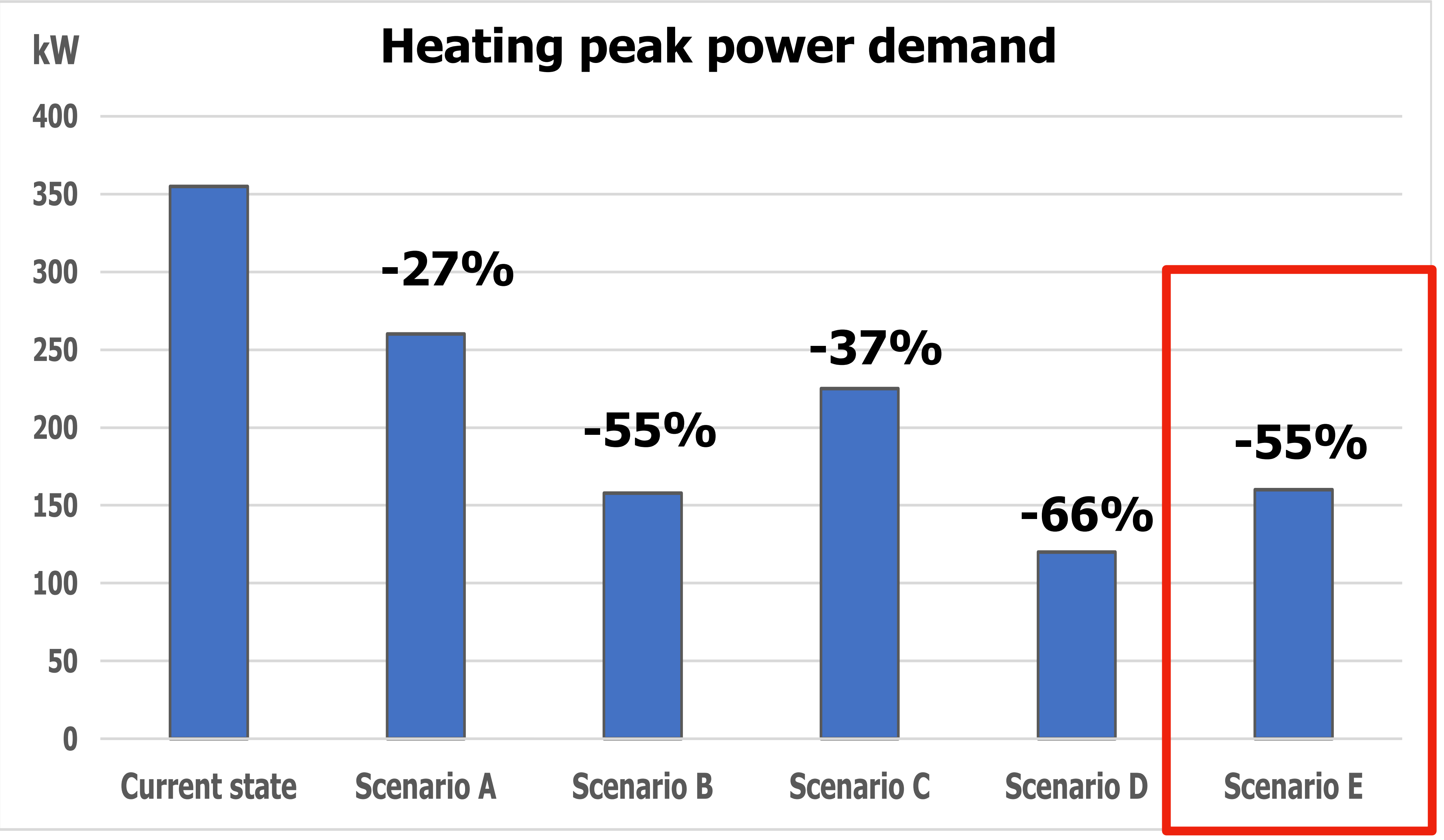
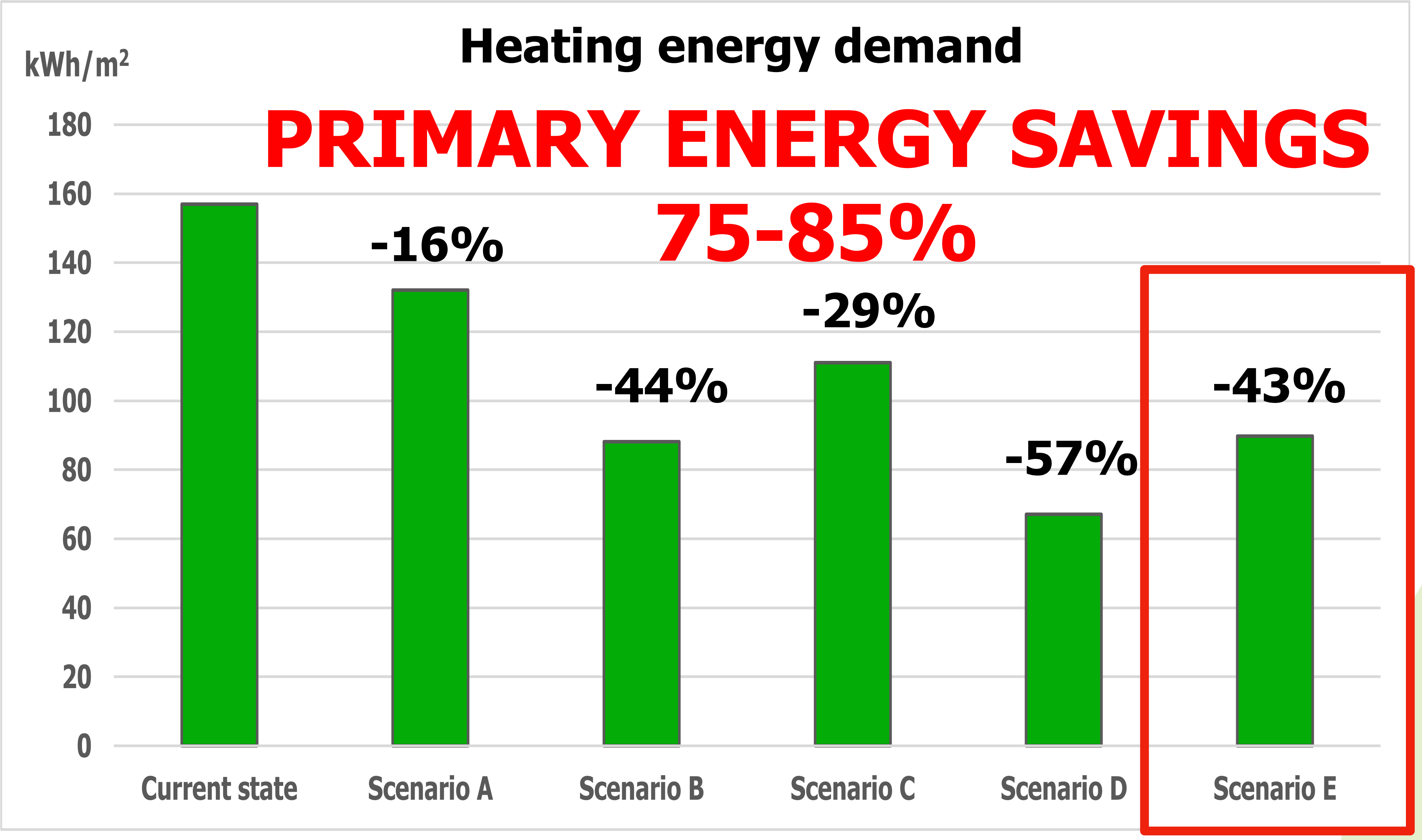
The e-SAFE concept

Demonstration activities: the virtual pilot building in Timisoara

Scenario	Description	Target
A	Thermal insulation of the opaque walls through the e-PANEL technology (with 15 cm of wood fiber insulating material)	U_{walls} = 0.29 W/(m²·K)
B	Scenario A + thermal insulation of the roof (with 12 cm of wood fiber insulating material)	U_{roof} = 0.29 W/(m²·K)
C	Scenario A + replacement of the existing windows with more performing ones.	$U_{windows}$ = 1.5 W/(m²·K) g-value: 0.67
D	Scenario A + thermal insulation of the roof + replacement of the existing windows.	See A and C
E	Scenario B + Mechanical Ventilation with 70% heat recovery efficiency in classrooms only, with a fresh air supply of 600 m³/h for 10 hours per day	See A and B

- Dynamic thermal simulations performed with standard 24h profiles
- Free cooling available when using Controlled Mechanical Ventilation (CMV, Scenario E)
- **Retrofit scenario E** is suggested because it **also helps solving stale air issues in the school**





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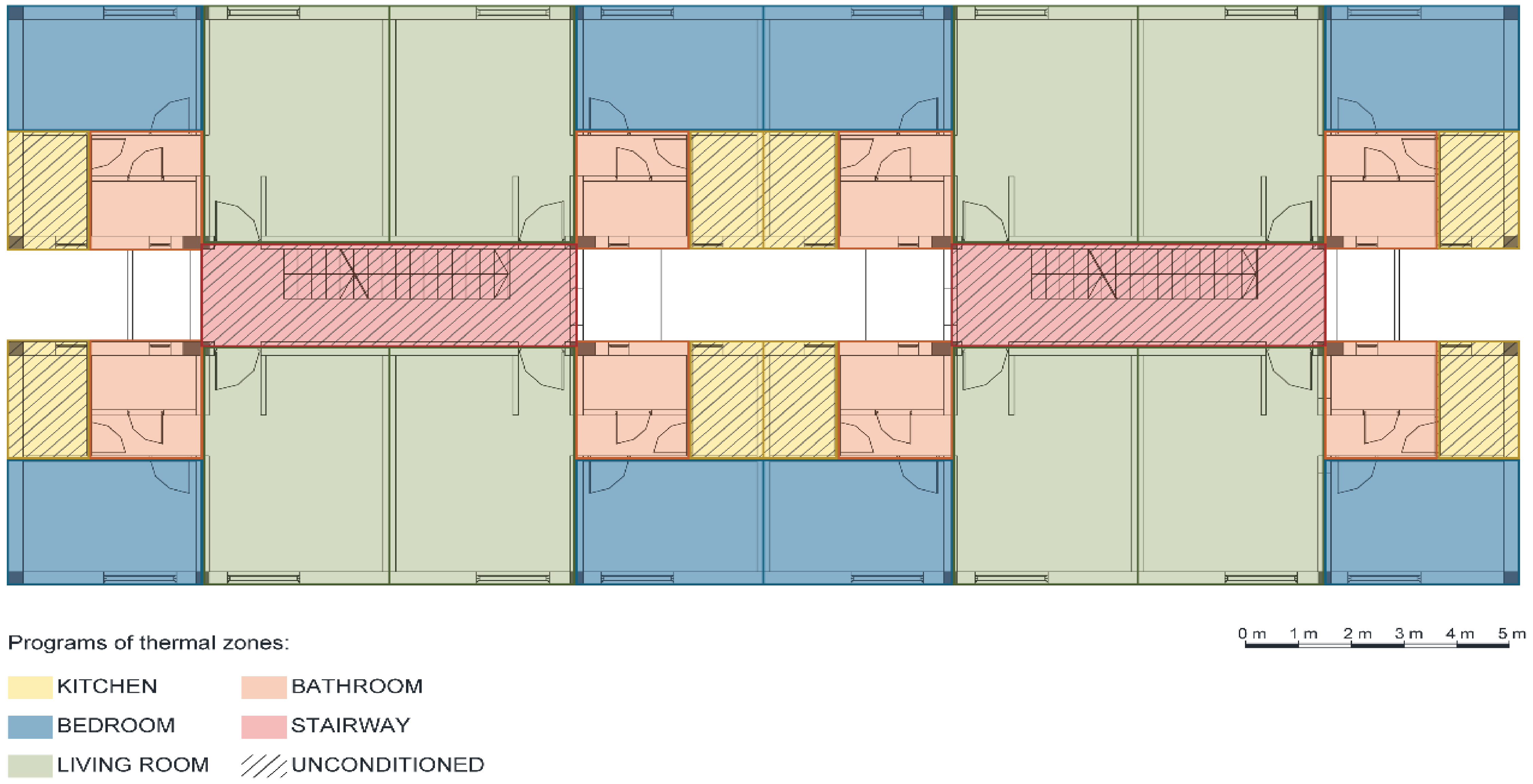
Demonstration activities: the virtual pilot building in Bucharest



One **public residential building** located in Bucharest (Central Romania)

- Built in the 1950s (never renovated)
- Gross floor area: about 1100 m^2
- Solid brick masonry – current U_{walls} = 1.7 W/(m^2K)
- Lightweight concrete slab – current U_{roof} = 1.2 W/(m^2K)
- Single-glazed metallic frame windows – current $U_{windows}$ = 2.7 – 6.0 W/(m^2K)
- District heating and radiators for providing DHW and space heating
- Some split units for providing space cooling

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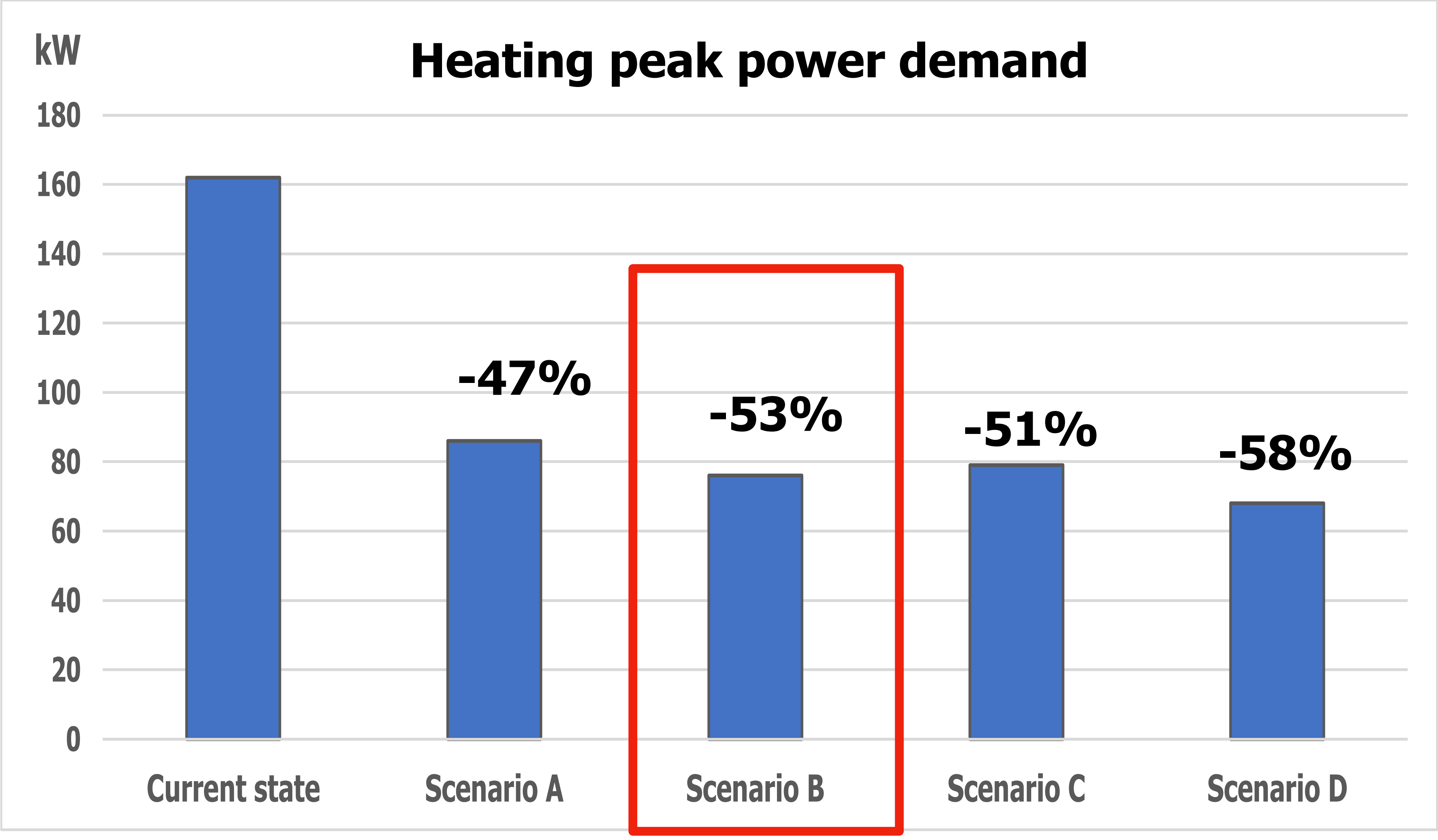
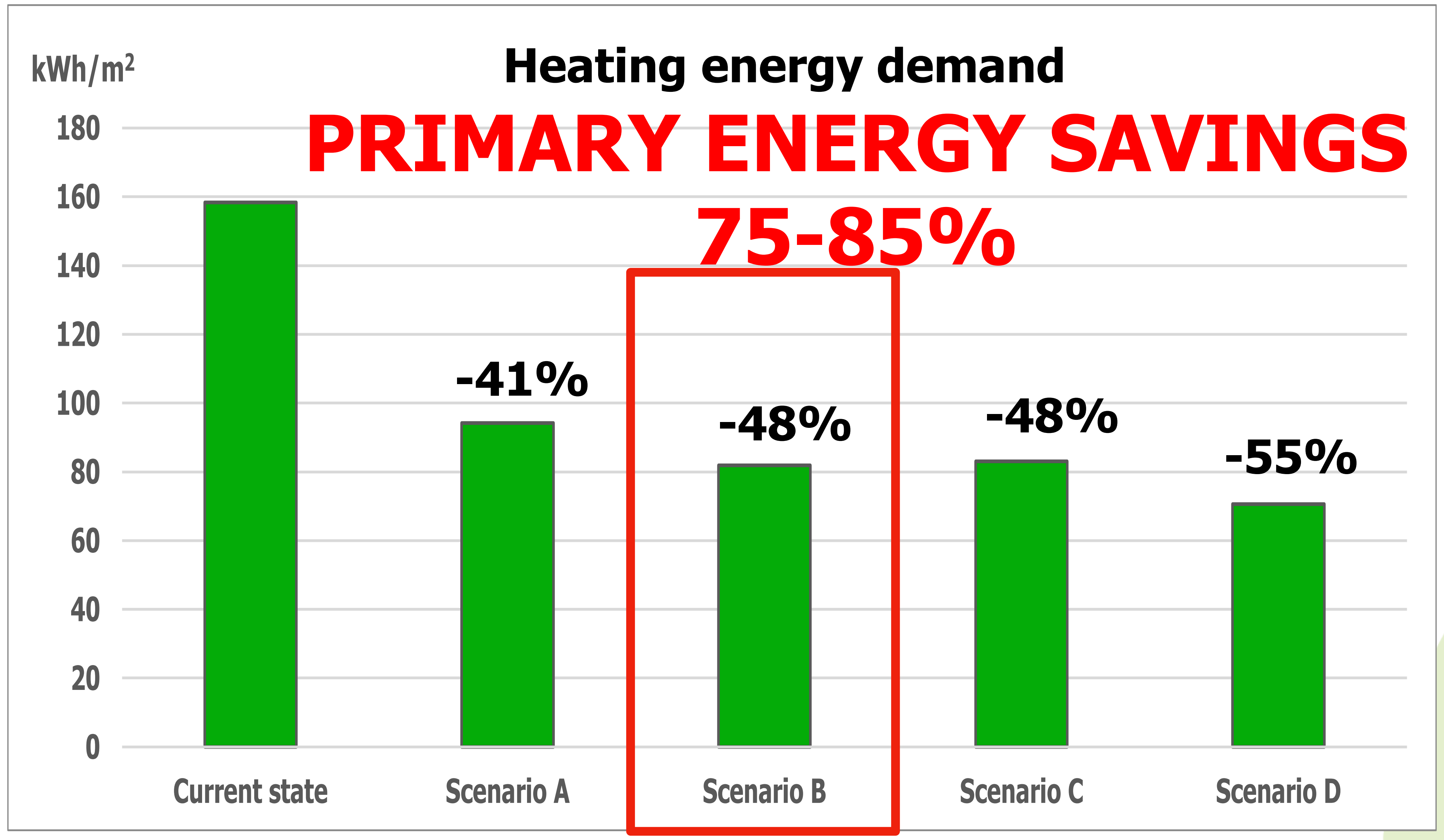
The e-SAFE concept

Demonstration activities: the virtual pilot building in Bucharest

Scenario	Description	Target
A	Thermal insulation of the opaque walls through 12 cm of XPS (lambda = 0.038)	U_{walls} = 0.27 W/(m²·K)
B	Scenario A + replacement of the existing thermal insulation of the roof slab with 12 cm of XPS (lambda = 0.038)	U_{roof} = 0.29 W/(m²·K)
C	Scenario A + replacement of the existing windows with more performing ones	$U_{windows}$ = 1.5 W/(m²·K) g-value: 0.68
D	Scenario A + thermal insulation of the roof + replacement of the existing windows	See A, B and C target values

- Dynamic thermal simulations performed with standard 24h profiles
- Cooling energy demand is negligible
- **Retrofit scenario B** is the most cost-effective





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THANK YOU FOR YOUR ATTENTION

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