

# Prefabricated buildings in East Europe - a retrofit challenge and opportunity

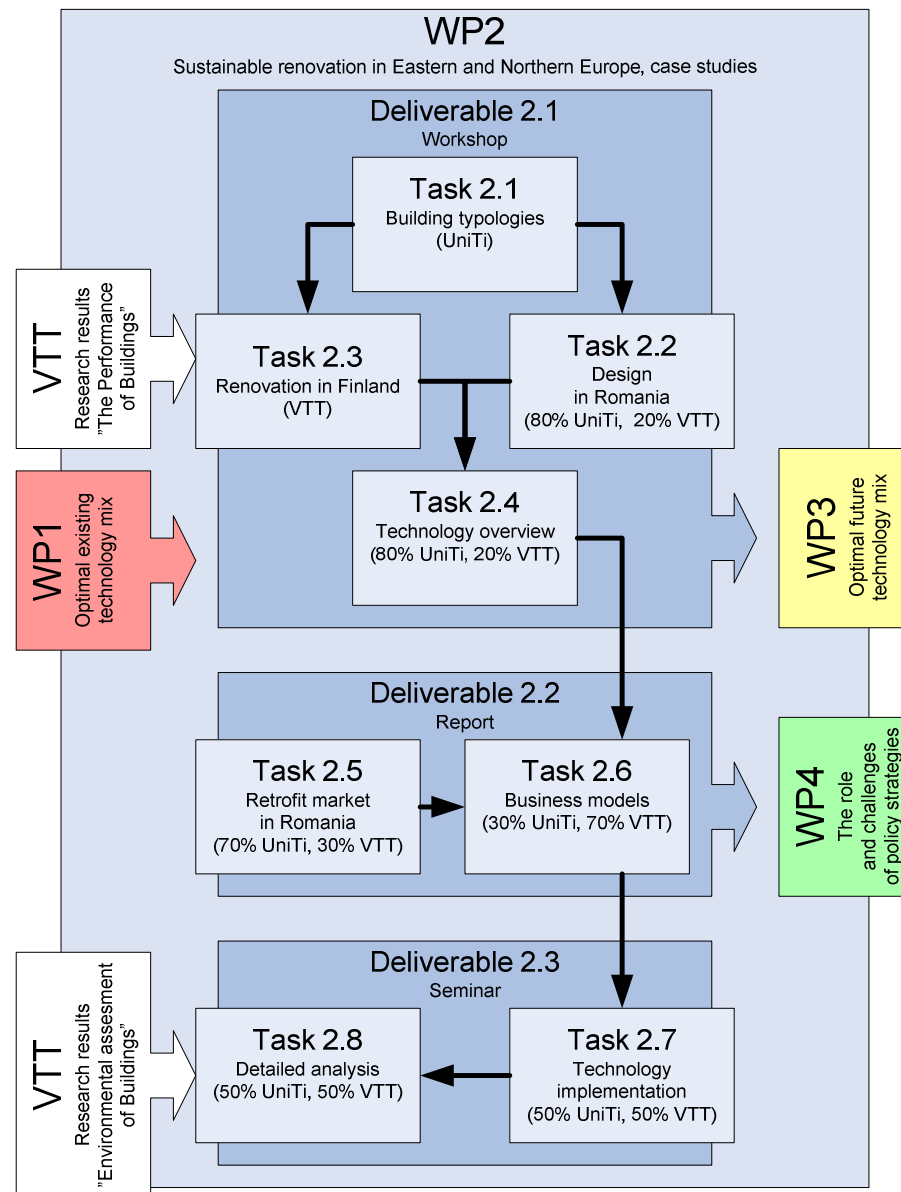


Botici A.<sup>1</sup>, Ungureanu V.<sup>1</sup>, Ciutina A.<sup>1</sup>, Nagy Zs.<sup>2</sup>, Talja A.<sup>3</sup>,  
Fülöp L.<sup>3</sup>.

<sup>1</sup> Politehnica University of Timisoara

<sup>2</sup> Technical University of Cluj

<sup>3</sup> VTT Technical Research Centre of Finland





## **CURRENT ISSUES AND APPROACHES FOR RETROFITTING OF LARGE PREFABRICATED CONCRETE RESIDENTIAL BUILDINGS**

- **Introduction**
- **Statistics**
- **Critical issues**
- **Possible interventions**
- **Structural design**
- **Energy assessment**

Introduction – Statistics - Critical issues -Possible interventions – Structural design - Energy assessment

- **Current energy policy and climate mitigation goals require distinct reductions of the primary energy demand and greenhouse gas emissions in the building sector.**

The existing building stock represents a special challenge since it proves very difficult to activate the large existing reduction potentials because of a variety of institutional, economic, informational and social reasons. Clear-cut technically and economically optimized retrofit strategies and policy instruments for different types of existing buildings are needed.

- **In the present context, about one third of the Romanian population lives in collective residential buildings with concrete structure including large prefabricated panels, built from 1953 to 1989.**
- **There is a need for guidelines and standardized approaches for different building types aiming at reducing the complexity which arises from the vast built space.**

**Introduction** – Statistics - Critical issues -Possible interventions – Structural design - Energy assessment

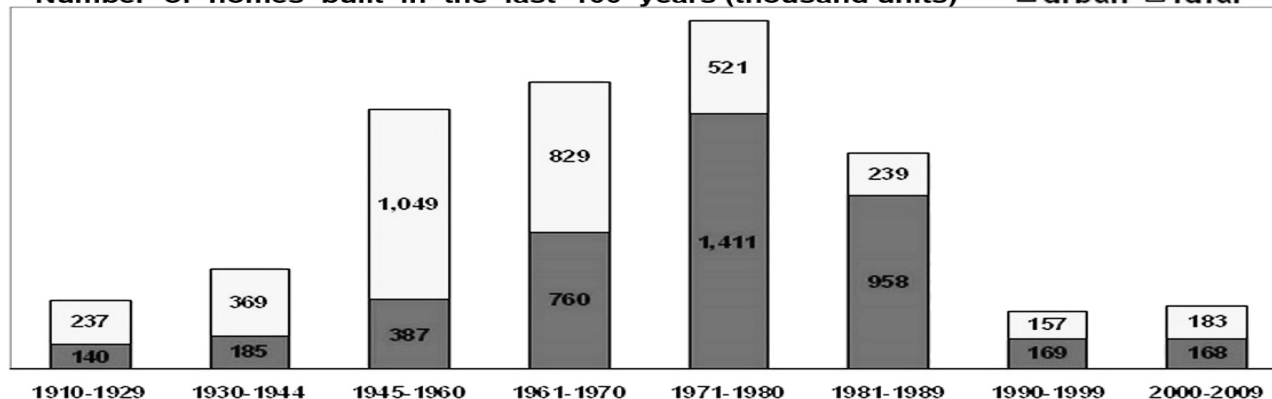
- **thermal and waterproof insulation and energy economy;**
- **acoustic protection;**

some of existing buildings (mostly those built before the '70) rise problems regarding:

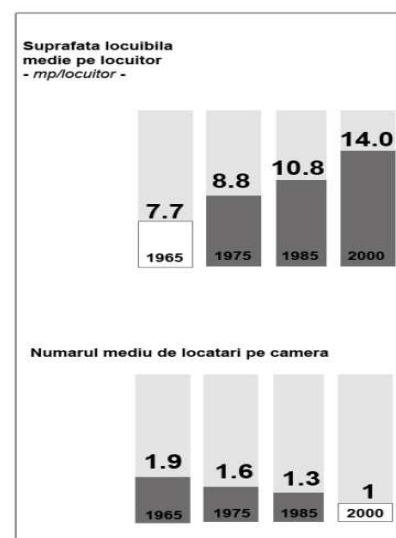
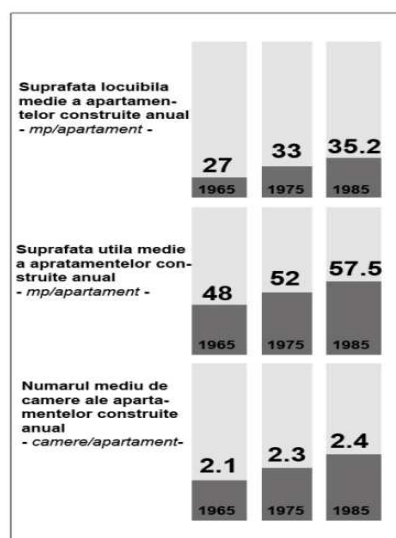
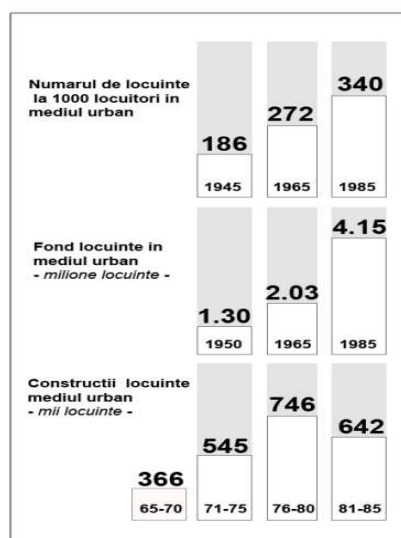
- **strength and stability;**
- **safety in exploitation,**
- **aesthetics and interior space partitioning**

Introduction – **Statistics** – Critical issues -Possible interventions – Structural design - Energy assessment

Number of homes built in the last 100 years (thousand units) ■ urban □ rural



Statistical data: existing building stock  
in Romania



LOCUINTE SUPRAFATA(MP) R+U  
8.071.912 303.300.454

4.234.173 159.234.576 URBAN

3.021.122 105.245.605 blocuri

71.35 % 66.1 %

TOTAL	Inainte de 1910	1910-1929	1930-1944	1945-1960	1961-1970	1971-1980	1981-1989	1990-1994	1995-1999
57431	93	123	239	634	4822	22355	25352	2832	773
24533	742	976	2341	3397	6667	6059	3497	488	208
81.964	835	1.099	2.580	4.031	11.499	28.414	28.859	3.220	314



Introduction – **Statistics** – Critical issues -Possible interventions – Structural design - Energy assessment

Statistical data: existing building stock in Timisoara



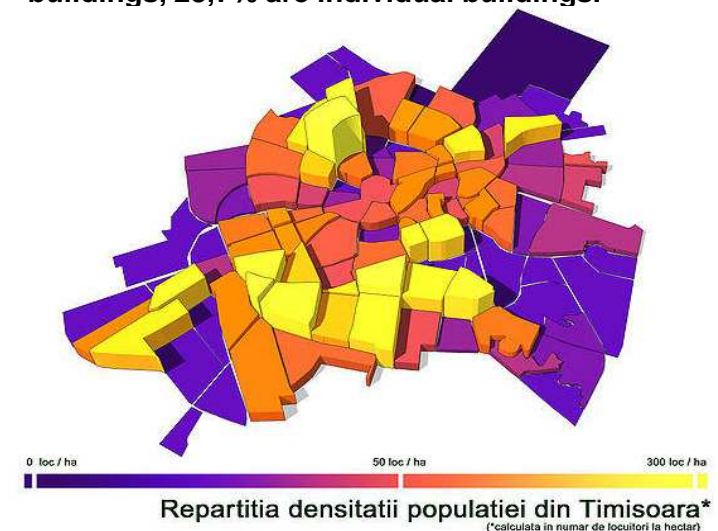
### LIVING TYPOLOGY

The urban area of Timisoara is divided into 10 districts with a total of 21.837 buildings of different types:

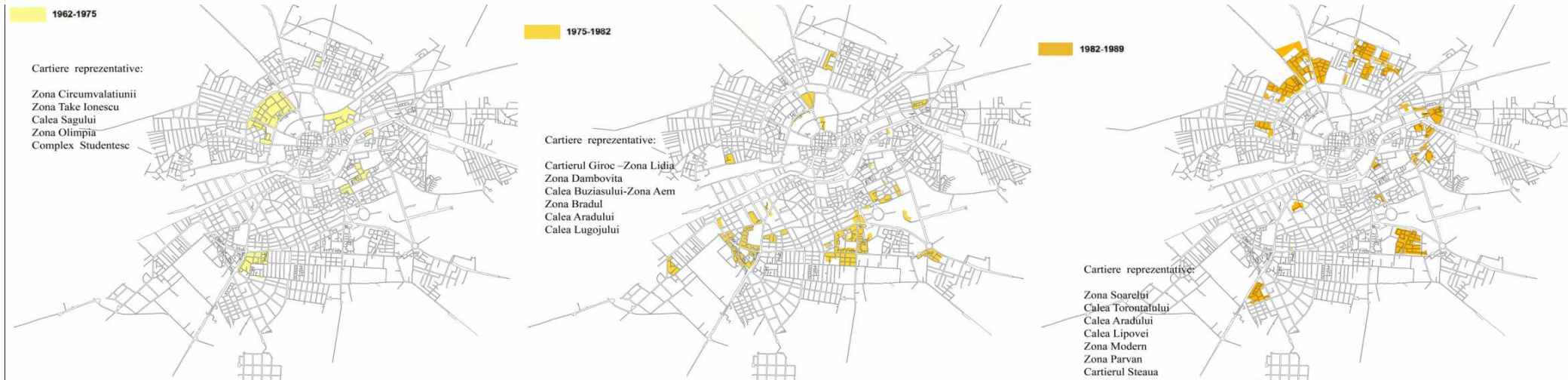
- individual buildings (15.039)
- multiple flats (3.639), having a height regime of 1 to 3 stories;
- collective buildings 5 to 11 stories.

The living field accommodate 122.195 flats, with a combined livable surface of 4.372.696 mp and 277.944 rooms.

From the total of flats, 71,3% are collective buildings, 28,7% are individual buildings.



Introduction – **Statistics** – Critical issues -Possible interventions – Structural design - Energy assessment



**Buildings in Timisoara were made out of large prefabricated panels were executed in 3 main stages using different typologies of standard projects:**

**1962-1975** - densification: 70 unit/10.000m<sup>2</sup>; distance between units of 60 m; Flats with relatively small living areas.

**1975-1982** - major densification; distance between units approximately 15 m; flats with relatively small living areas; commercial areas were integrated on the first floor.

**1982-1989** - densification of 80 unit/10.000m<sup>2</sup>; distance between units having approximately 40 m and afferent to those, multiple community buildings



Introduction – **Statistics** – Critical issues -Possible interventions – Structural design - Energy assessment

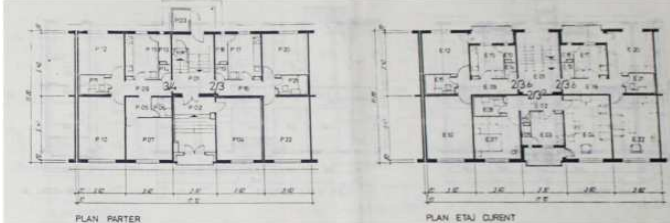
### 3 types of standard projects built with high frequency:

- I.P.C.T. project type 744 used between 1962-1975
- I.P.C.T. project type 770 used between 1975-1982
- I.P.C.T. project type 1340 used between 1975-1982

At the basis of the 770 project realized in 1978 there were 3 major typologies (series) each of them being and having the cross-sections(Pa1--Pa4; Pb1--Pb4) assembled in 5 known ways to realize an assembly In sections (middle- middle, point-middle, middle-point, middle-end). The 3 project series (Pa; Pb; Pc) have different characteristics regarding orientation, accessibility, position of vertical circulation, layout dimension, etc. Pa and Pc series have double orientation while Pb series was realized with a simple orientation. Pc series are especially made to connect L or U sections, these series being used in various combinations with other series. These are used mostly to solve straight or splay angles.

#### I.P.C.T. project type 770

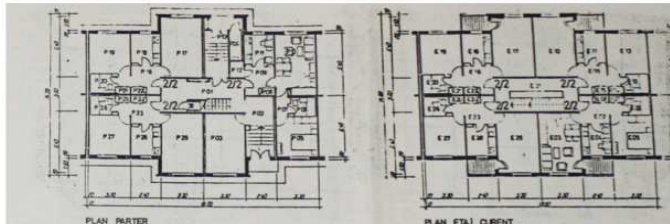
PLAN/SECTIUNE TIP SERIA Pa PROIECT 770-78



PLAN/SECTIUNE TIP SERIA Pc PROIECT 770-78



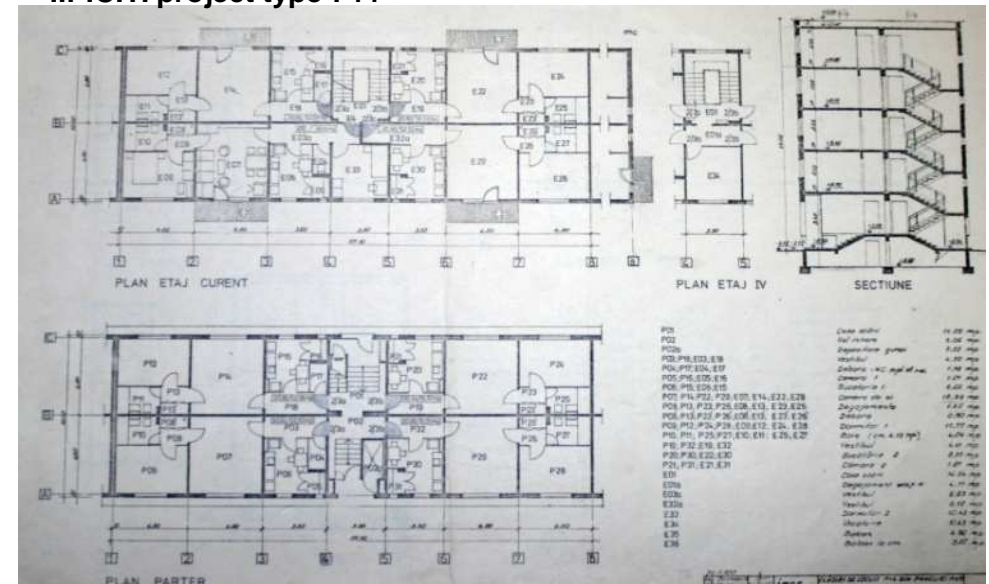
PLAN/SECTIUNE TIP SERIA Pb PROIECT 770-78



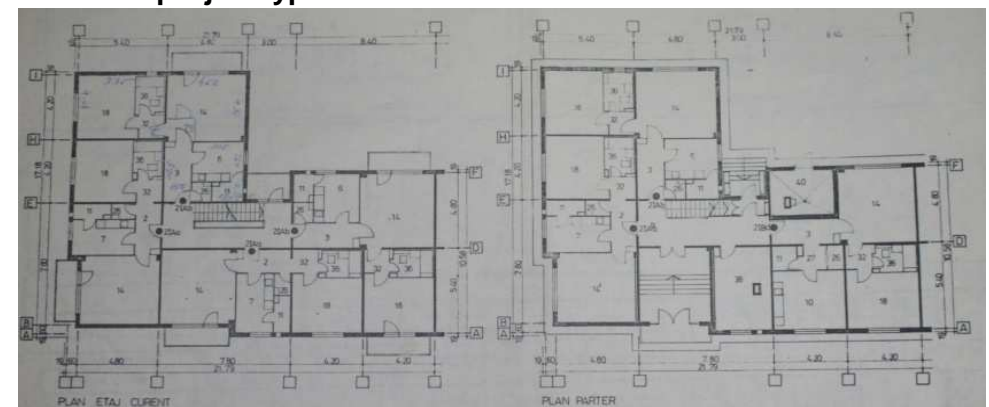
PLAN/SECTIUNE TIP SERIA Pc PROIECT 770-78



#### I.P.C.T. project type 744



#### I.P.C.T. project type 1340



Introduction – Statistics - **Critical issues** - Possible interventions – Structural design - Energy assessment

## Residential areas - CURRENT STATUS



### Social issues regarding habitants:

- inadequate interior space regarding the number of bedrooms and living area;
- poor division of interior space;
- high maintenance costs;
- poor thermal and noise insulation;
- nonexistent external residential spaces i.e. green spaces, children's playgrounds, adequate parking lots;

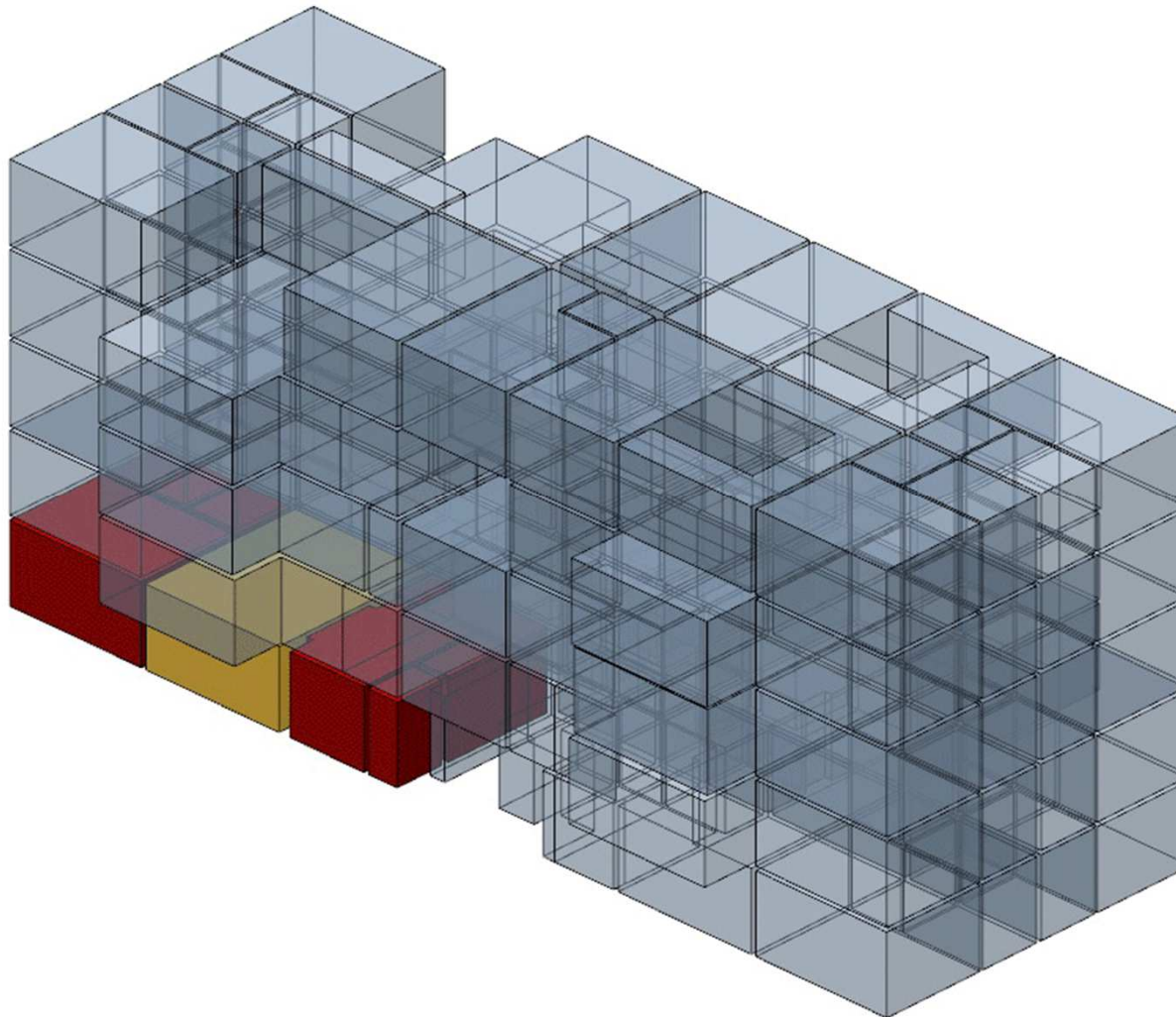
### Urban major disfunctionalities:

- lack of green spaces and parking
- lack of concern for the maintenance of overall building - facades, cornices, balconies
- non-unitary rehabilitation interventions (the attic) of the assemblies
- abusive extensions of buildings at ground level
- mix of collective housing and individual homes, placed at a relatively short distance
- lack of green spaces and parking
- lack of concern for the maintenance of overall building - facades, cornices, balconies
- non-unitary rehabilitation interventions (the attic) of the assemblies





## Interventions on apartments by redesigning interior spaces:



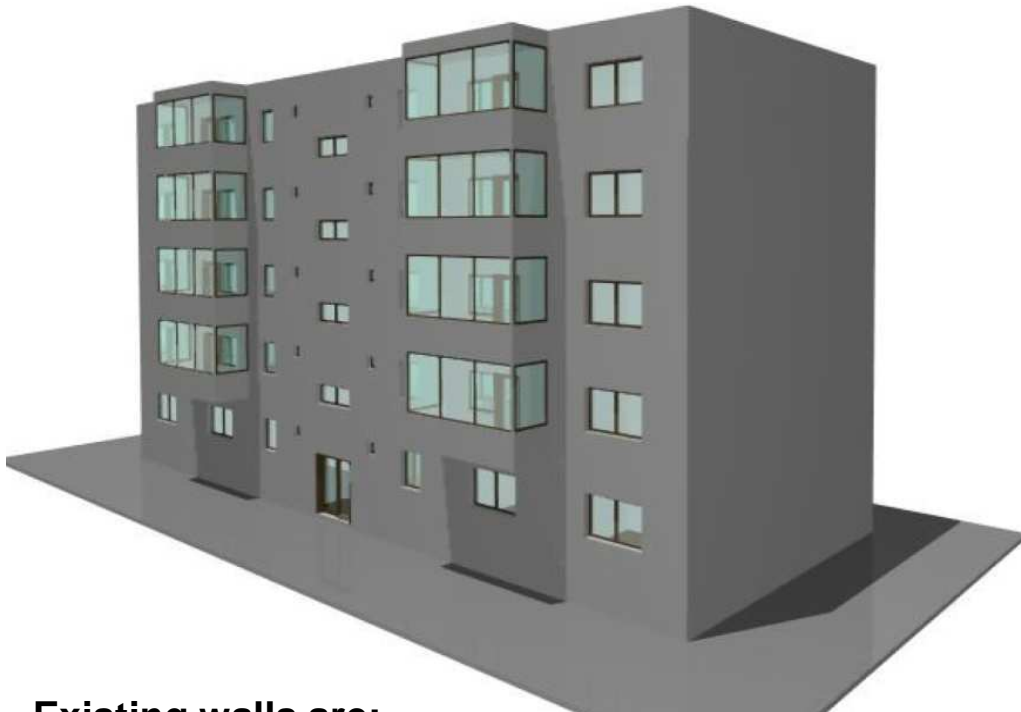
The goal of this particular research is:

- to configure different types of flat reconfiguration, and to find possible ways of grouping them into the existing structure.
- to determine the main advantages of these matrix;
- to conform them to current design codes;

Introduction – Statistics - Critical issues - **Possible interventions** – Structural design - Energy assessment

## Interventions on apartments by redesigning the interior spaces:

I.P.C.T. project type 744: 1962-1975



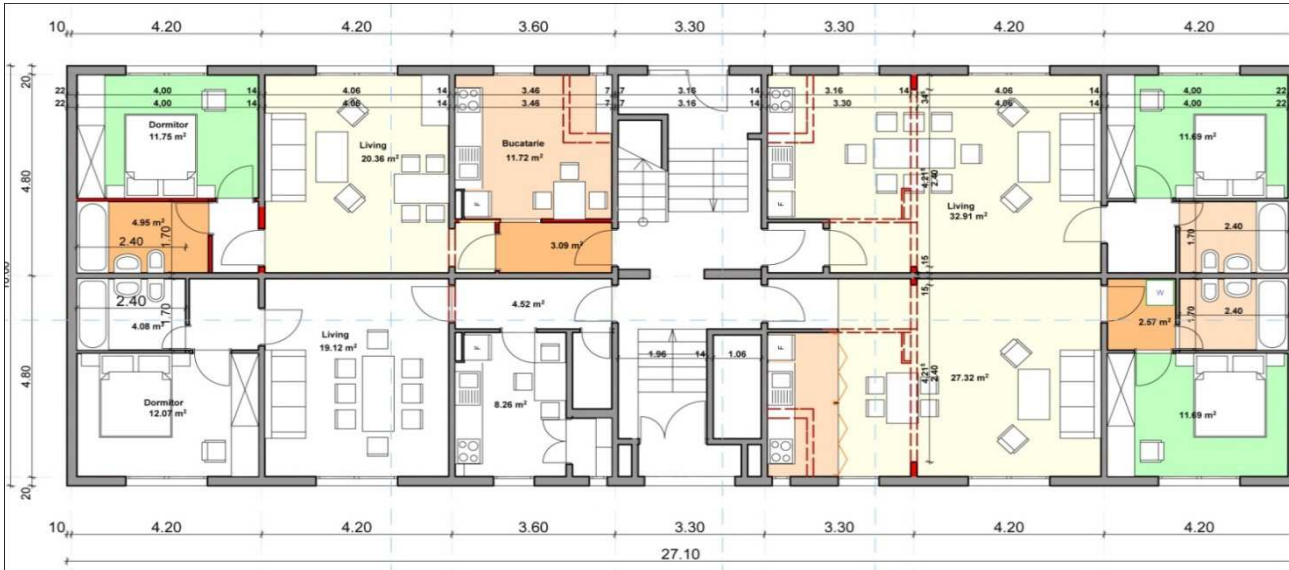
Existing walls are:

- structural, of diaphragm type, large precast concrete panels
- nonstructural for partitioning purposes.

Exterior walls are: large precast concrete panels, three layered,

Introduction – Statistics - Critical issues - Possible interventions – Structural design - Energy assessment

## A. Interventions by reconfiguring the areas delimited by vertical spaces.



- repartitioning through redesign of interior spaces and conversion of nonstructural walls

- reconfiguration through redesigning and extending the openings in the diaphragm walls;

Developing optimal structural surface area for openings taking into account:

- the period in which the panels were made (structural: reinforcement and seismic conformation)
- building lifecycle and capacity to increase the comfort of living



Introduction – Statistics - Critical issues - Possible interventions – Structural design - Energy assessment

## B. Expansion of existing flats through horizontal union.



- The pairing of two apartments from the same storey and turning them into one apartment.
- This kind of intervention needs imposes on reorganization of interior areas through major interventions on vertical structural diaphragm walls.
- From a social stand point, a clearance of the public zone allocated for parking lots is resulting.
- It conducts to urban decrease of densification.

Introduction – Statistics – Critical issues – Possible interventions – Structural design – Energy assessment

## C. Expansion of existing flats through vertical union.

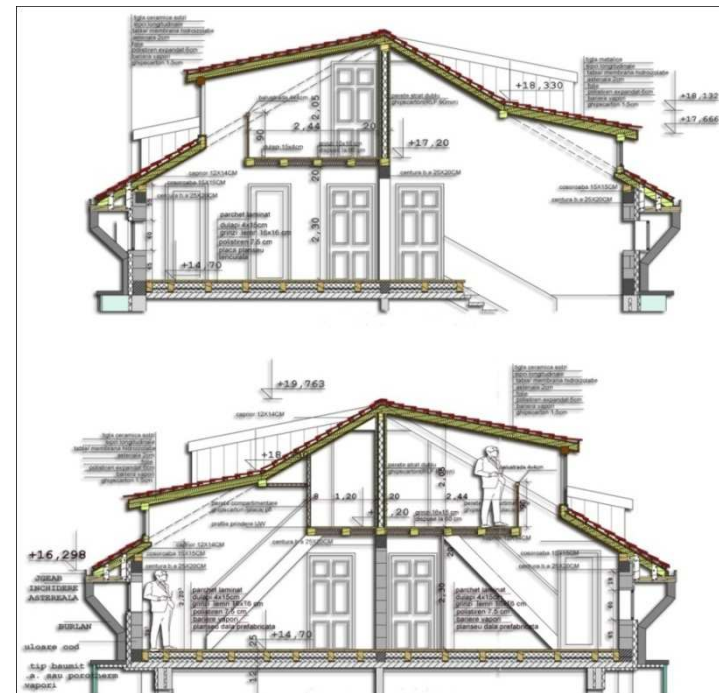
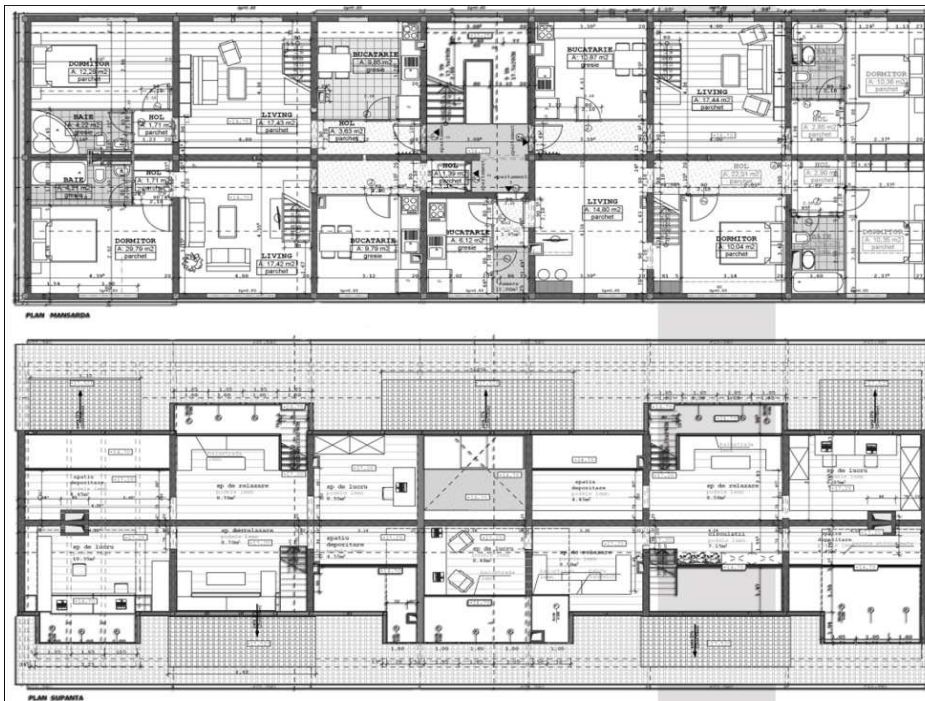


- The pairing of two apartments at different storeys and turning them into one apartment by creating interior stairs.
- Creating flats with ample living areas and increased comfort.
- This kind of expansion imposes reorganization of interior areas through major interventions both on vertical structural diaphragm walls as well as structural floors.
- It conducts to urban decrease of densification.



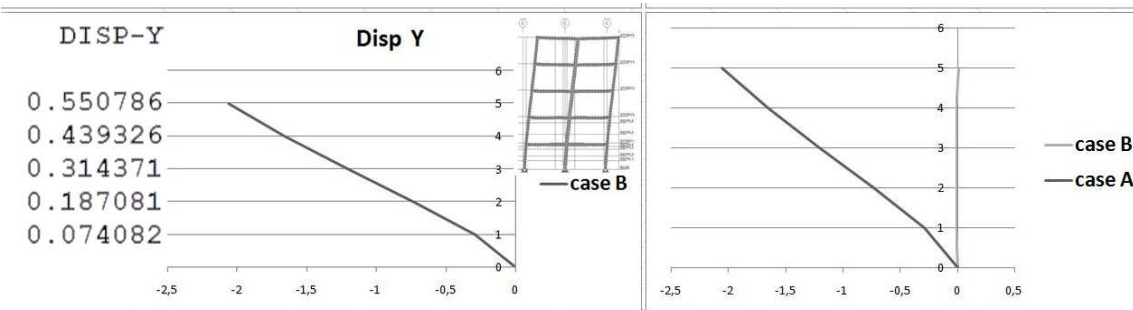
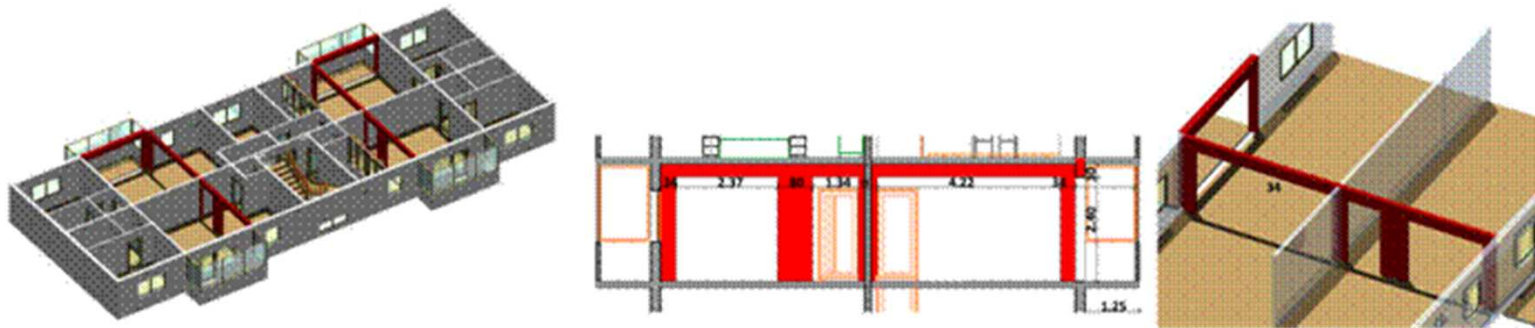
Introduction – Statistics - Critical issues - Possible interventions – Structural design - Energy assessment

## Interventions on the attic areas:



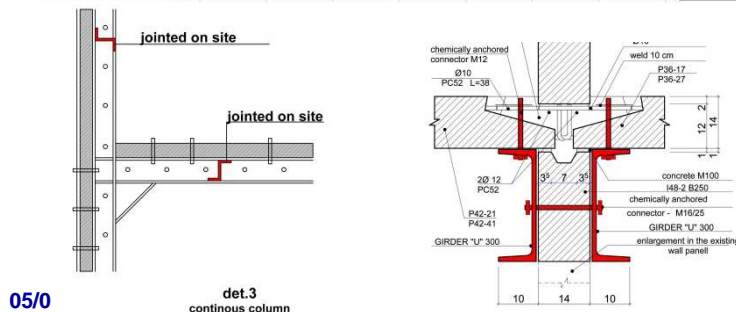
Introduction – Statistics - Critical issues -Possible interventions – **Structural design** - Energy assessment

## Interventions on apartments by redesigning interior spaces:



**Preliminary structural analysis show that:**

- Even in the case of high seismic intensities (such as 0,32g) the repartitioning of spaces is possible;
- The structural response remains about the same but considering limited intervention on walls;
- Strengthening of new openings is necessary;

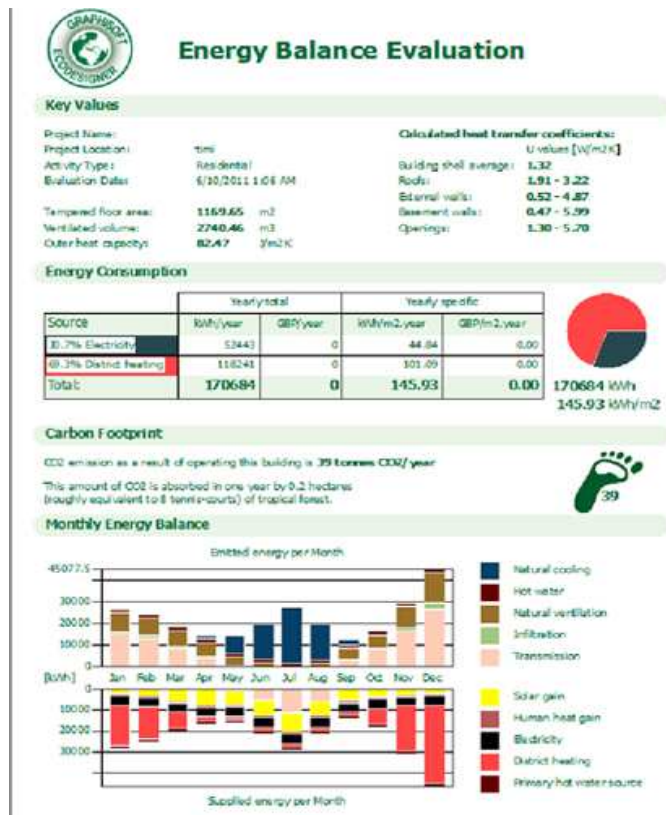




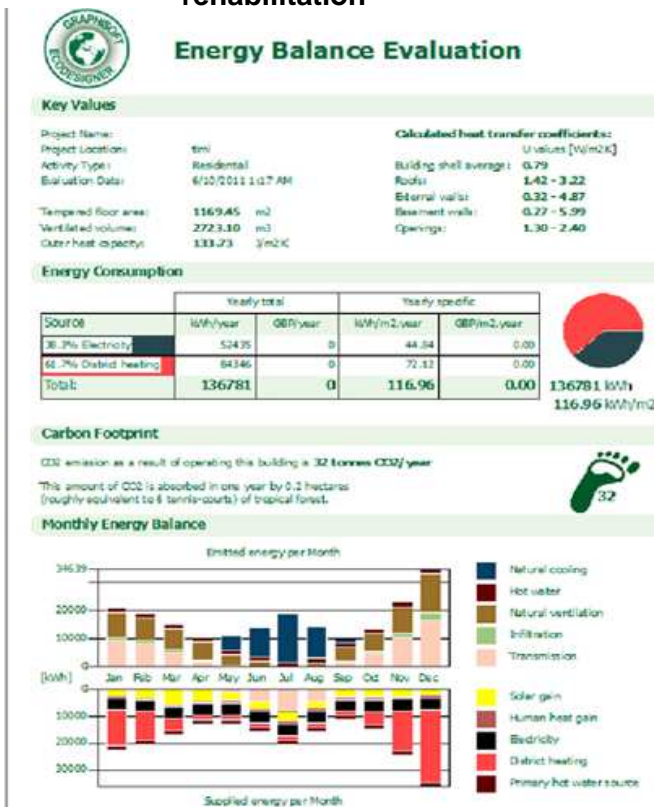
Introduction – Statistics - Critical issues -Possible interventions – Structural design - **Energy assessment**

## Energy Assessment

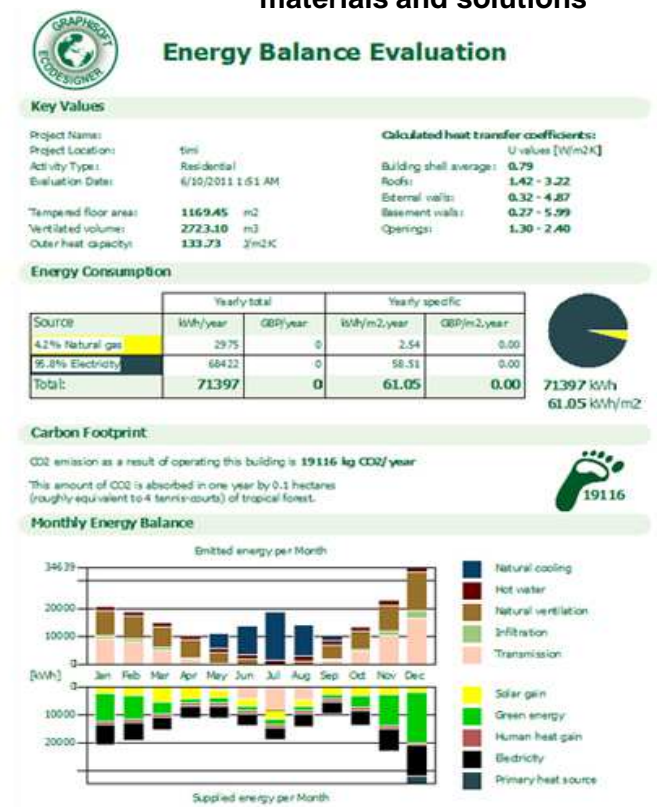
### Existing building energy study



### Energy study for classical thermal rehabilitation



### Energy study for thermal rehabilitation using modern materials and solutions





## **CONCLUSIONS:**

- **There is a substantial building stock consisting of large prefabricated concrete residential buildings;**
- **There is a major necessity concerning the rehabilitation of this residential units;**
- **Concrete residential buildings present the largest retrofitting challenge in Eastern European countries; and one of the best opportunities to substantially improve energy efficiency of residential buildings on the large scale in the EU;**
- **There are modern technologies with a great potential regarding energy consumption economy.**
- **The goal is to systematically evaluate retrofitting strategies regarding their technological applicability, economic performance, impact on primary energy and CO<sub>2</sub>-emissions, and interactions with other retrofit needs and to seek for adequate and tailored policy strategies and instruments, depending on building types, actors and institutional or country contexts.**

## Specifics of the retrofit market in Romania

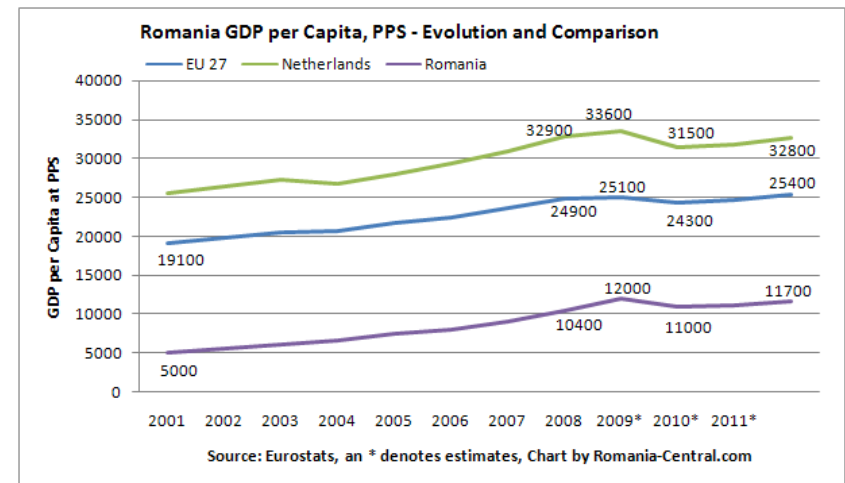
- **Market summary**
  - Retrofitting potential
  - Market psychographic
  - Customer behavior
- **Market needs**
- **Competition**
- **Driving Forces**
- **Key-issues for success & Critical issues**
- **Success stories of the thermal retrofitting**
  - **Conclusions**

Market summary - Needs – Competition - Driving Forces - Keys & Critical issues - Success stories – Conclusions - Plans



## Retrofitting potential

- Population: 21,677,616 (2002)
- Tendency: decreasing
- GDP per capita: 12,000 Eur. (2008)
- Inflation rate: 5 %
- Unemployment rate: 4,4 %
- Prefab concrete element buildings 161.347;
- 3.021.122 apartments in prefabricated concrete buildings with a living area of 105.245.605m<sup>2</sup>;
- Estimating average price of 1000 Eur/m<sup>2</sup>
- Considering 10%/year necessary to retrofit & invested value of 10% of the total value – estimated market: 1050 million Euro



Market summary - Needs – Competition - Driving Forces - Keys & Critical issues - Success stories – Conclusions - Plans

## Market psychographic

- Home is a priority
  - Public area is out of focus
  - Global view of facade neglected
  - Lot of things to do for improvement
- 
- Home - interior



- Home - exterior



Market summary - Needs – Competition - Driving Forces - Keys & Critical issues - Success stories – Conclusions - Plans

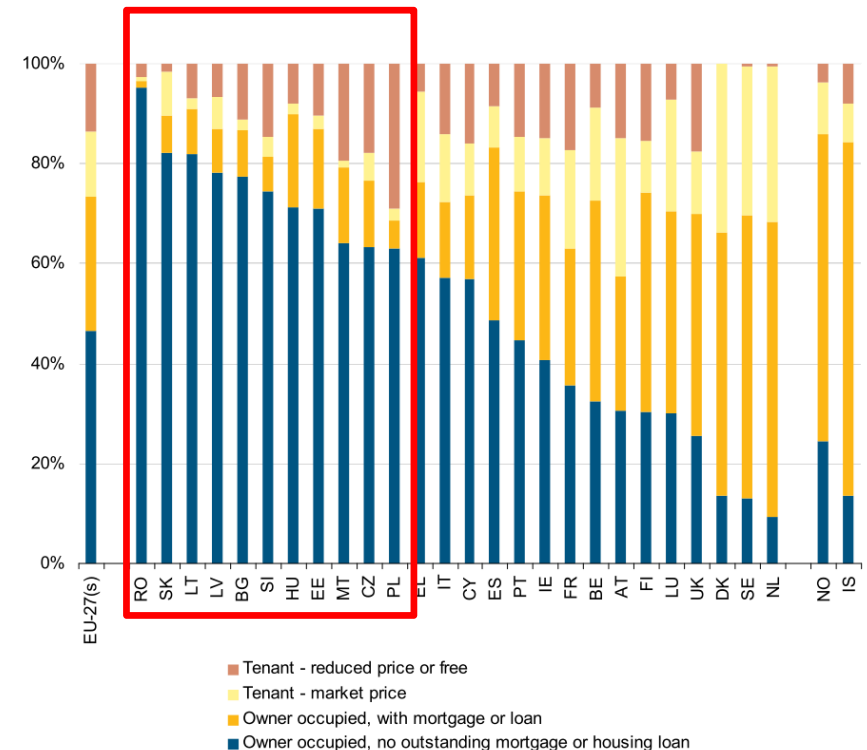
## Customer behavior

- Home ownership rate very high – low mobility
- Global view of facade neglected – “*Not mine. Not my problem!*” attitude.
- Nominal net income quite low (215 – **370** – 995 Eur.) monthly
- Level of trust quite low – like most of East Europe.
- Young generation - credits



front page article published by the Federation of Homeowners Association on the news that the government is launching a thermal rehabilitation program – Caption reads

“Keep eyes on the pocket, they are preparing a new cheating scheme masked as – Thermal rehabilitation program”





## Market needs

To provide the opportunity for the people to express who they are

- **Selection:** a wide variety of material for retrofitting / redesign
- **Accessibility:** government program for energy savings, limited funds
- **Customer design services:** *retrofitting solution, details provided for owner associations can improve the success!*
- **Competitive pricing:** people don't know what they pay for

Market summary - Needs – **Competition** - Driving Forces - Keys & Critical issues - Success stories – Conclusions - Plans

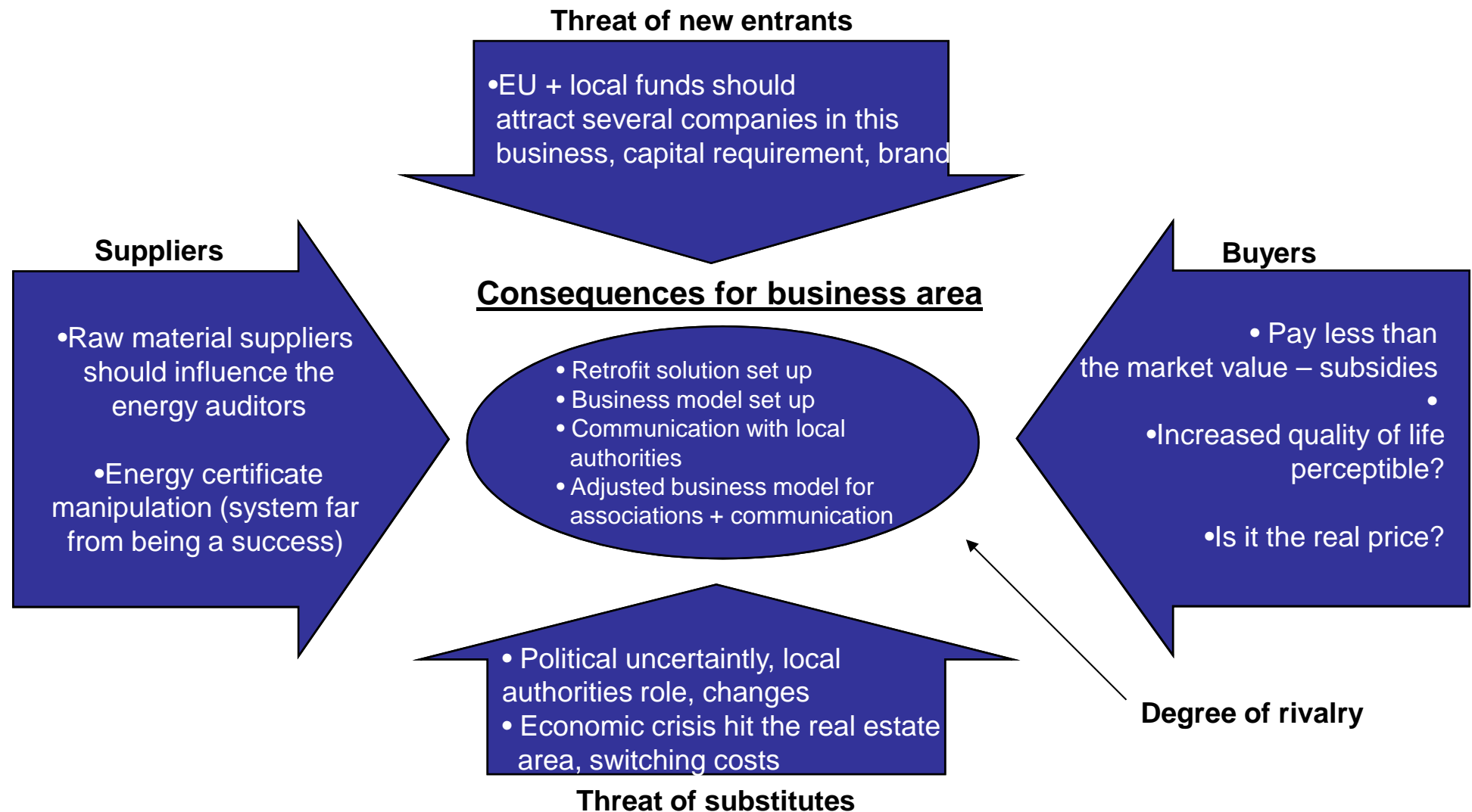
## Competition

- New market - not a big competition
- Pilot projects: started by different companies
- Over-roofing: tried since 2001, competitive business area without government support
- Insulation improvement: several projects, but numerically negligible, compared with the total number of buildings



Market summary - Needs – Competition - **Driving Forces** - Keys & Critical issues - Success stories – Conclusions - Plans

## Driving Forces



## Key-issues for success

- Added value: should increase the property value
- Paid price: acquisition price + investment should be less than market average price
- Procedure: for developers, making easier the decision
- Communication and change process for existing associations



## Critical issues

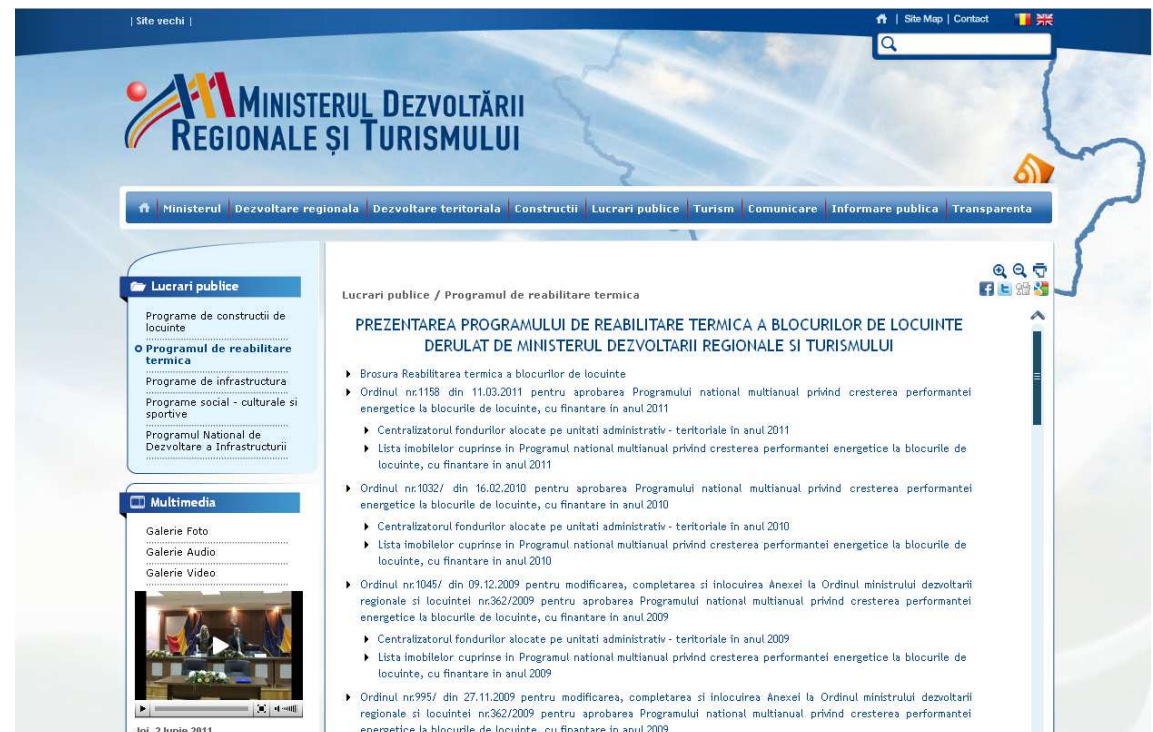
- Local people protect their business interest
- Economical performance in a permanently changing environment
- Decision in the actual form of the association is very complicate and time consumer



Market summary - Needs – Competition - Driving Forces - Keys & Critical issues - **Success stories** – Conclusions - Plans

## Success stories of the thermal retrofitting

- Started in 2009
- Applied examples shows that even this program, people believes that they pay more than the real price of retrofitting
- Owners suspect arrangements between local authorities and construction companies
- Cost sharing:
  - 20% of the cost - supported by the owner
  - 30% local authority
  - 50% ministry of public works





Market summary - Needs – Competition - Driving Forces - Keys & Critical issues - Success stories – Conclusions - Plans

## Târgu Mureș, Ground+3 floors – Thermal rehabilitation and over-roofing

16 apartments (2-3 rooms), Refurbished 2007



- ✓ Over-roofing with living space
- ✓ External thermal insulation – 10cm polystyrene
- ✓ Replacement of external doors and windows
- ✓ Re-working of wall surfaces
- ✓ Insulating hot water pipes
- ✓ Changing batteries in bathrooms
- ✓ Changing heating elements in apartments

### Costs:

Audit and design: 5750€

Works: 59000€ (3687€/ap)

- MDLPL 20000 €
- Local council 19500 €
- Owners 19500 € (1218€/ap)
- Estimated price 800 €/m<sup>2</sup>



[http://www.turism.gov.ro/media/files/articles/foto\\_reabilitare\\_termica.pdf](http://www.turism.gov.ro/media/files/articles/foto_reabilitare_termica.pdf)

## Piatra Neamț – Thermal rehabilitation and over-roofing

45 apartments + 9 created by over-roofing  
Refurbished in 2007



- ✓ External thermal insulation (12cm polystyrene)
- ✓ Timber roof structure with LGS sheet covering
- ✓ PCV based window frames including balconies
- ✓ Exterior doors
- ✓ External finishing

### Costs:

Audit: 6500€

Design: 12400€

Works: 300 000€

- Rehabilitation: 210 000€ (4666 €/ap)

-Over-roofing: 90 000€ (10000 €/ap created)

-Estimated price 600 €/m<sup>2</sup>



## Conclusions

- Needs exist – only small stimulation can create good results
- New market – rapid development possibilities
- Some financing programs for funds – particular rules & complicate procedure (bureaucracy)
- Specific culture – requires to fit the action plan to this aspect
- Misconceptions/Fears/Suspensions of the Owner Association” – slow down the decision process



## Plans

- Detailing a set of refurbishment solutions for certain case studies – Balance of Environmental, Social and Economical sustainability goals to be reflected.
- Market study extended to Poland, Czech Republic (East Germany a retrofit bonanza & Finland a comparative basis) – almost ready.
- Survey for consumer attitude to sustainability goals (*based on VTT-ProP hierarchy*) – ongoing.
- Looking for real project cases. Developing network of interested parties – industry, authorities and research financing.