Retrofitting of Social Housing. Policy and Financing Options

SESSION VI: Social Housing as Priority in the Intelligent Energy- Europe Programme

InoFin

Innovative Financing of Social Housing Refurbishment in Enlarged Europe

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On behalf of the InoFin-Team

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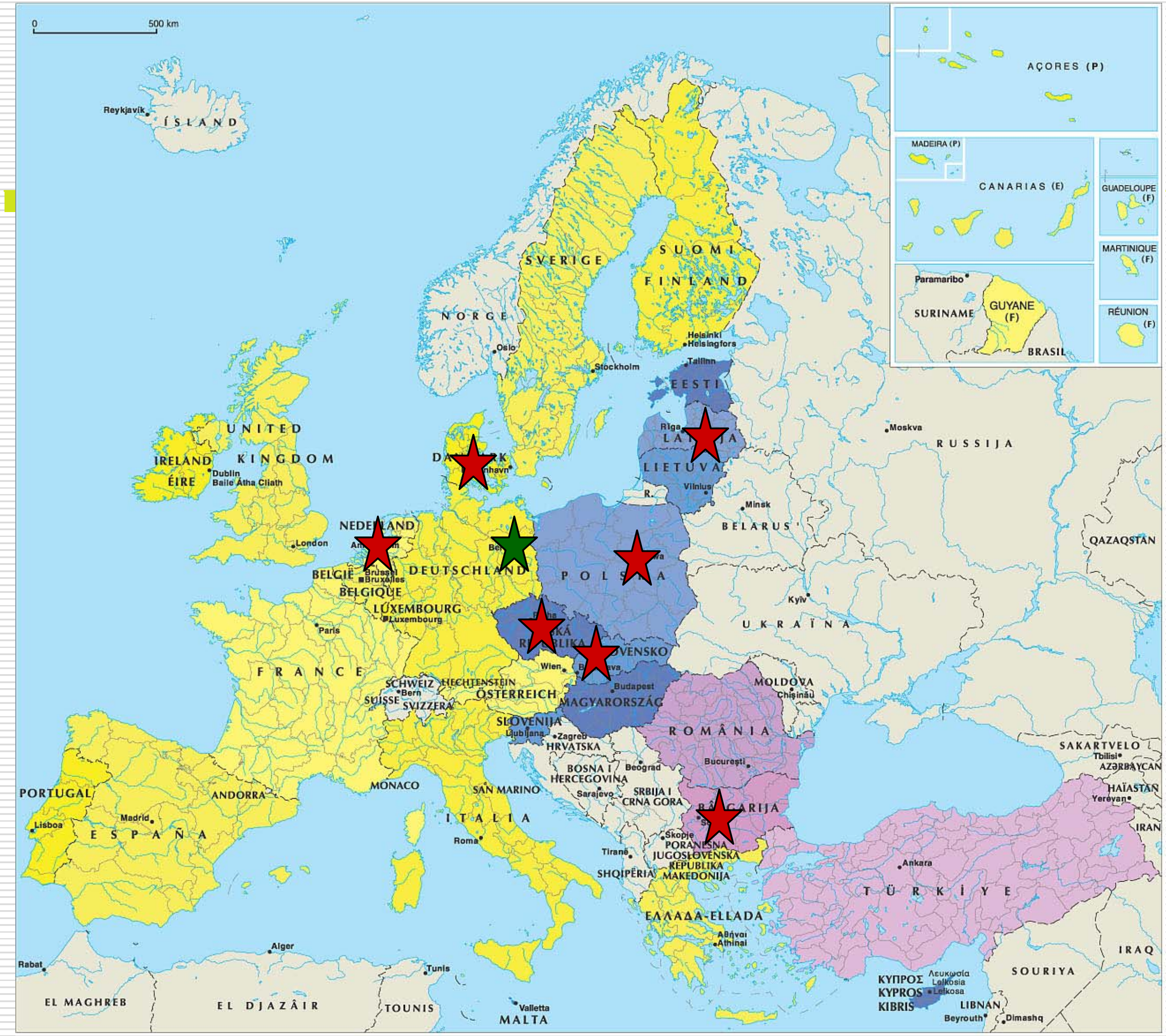
well spread



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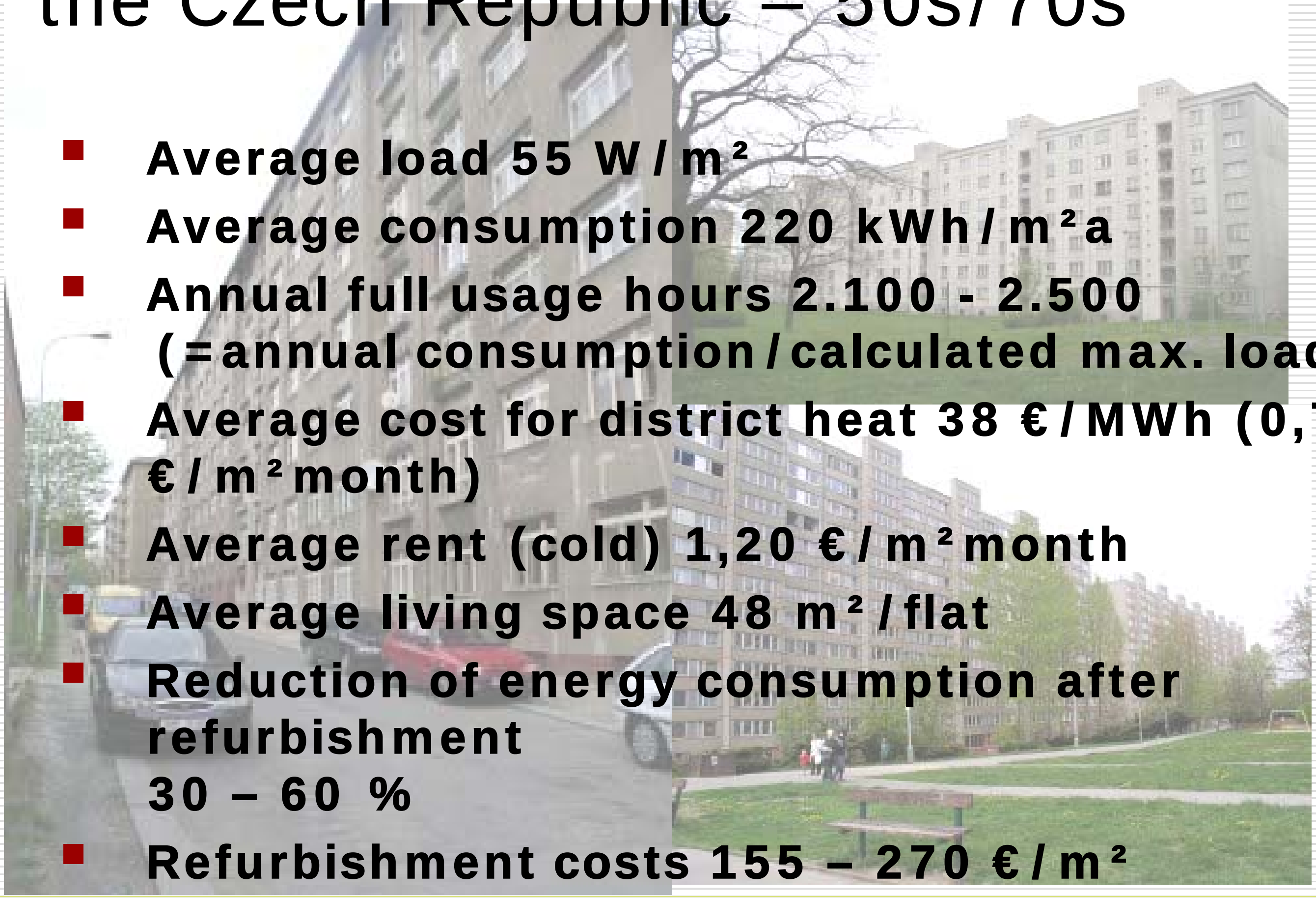
InoFin Team

(1) CEBra - Centre for Energy Technology Brandenburg GmbH, Brandenburg, Germany
(2) ECNet - Energy consulting network Aps, Denmark
(3) ENVIROS, s.r.o., Czech Republic
(4) ECN – Energy research Centre of the Netherlands
(5) SEC – Sofia Energy Centre, Bulgaria
(6) Ekodoma, Latvia
(7) ECB – Energy Centre Bratislava, Slovakia
(8) NAPE – Nat. Energy conservation agency, Poland

Brandenburg – typical building with 50 flats

- Average load 70 W/m^2
- Average consumption 160kWh/m^2a
- Annual full usage hours 2.100-2.500 (=annual consumption/calculated max. load)
- Average cost for district heat 60€/MWh (0,80 €/m^2month)
- Average rent (cold) 3,20 €/m^2month
- Average living space 60 m^2/flat
- Reduction of energy consumption after refurbishment 40%
- Refurbishment costs 700 – 800 €/m^2

Typical residential building in the Czech Republic – 50s/70s



- **Average load 55 W/m²**
- **Average consumption 220 kWh/m²a**
- **Annual full usage hours 2.100 - 2.500 (=annual consumption/calculated max. load)**
- **Average cost for district heat 38 €/MWh (0,70 €/m²month)**
- **Average rent (cold) 1,20 €/m²month**
- **Average living space 48 m²/flat**
- **Reduction of energy consumption after refurbishment 30 – 60 %**
- **Refurbishment costs 155 – 270 €/m²**

Poland – typical building with 50 flats

- **Average load 100 W/m²**
- **Average consumption 300 kWh/m²a**
- **Annual full usage hours 2.100-2.500**
  (=annual consumption/calculated max. load)
- **Average cost for district heat 90 €/MWh (0,80 €/m²month)**
- **Average rent (cold) 0,20 €/m²month**
- **Average living space 43 m²/flat**
- **Reduction of energy consumption after refurbishment 43%**
- **Refurbishment costs 50 – 200 €/m²**

Energy costs in €/MWh

	BG	CZ	LV	Sk	Pl
DH	28	44	32	44	35
Nat G.	34	34	21	29	32
Oil	97	44	36	41	68
Coal	12	13	8	17	25
Wood	10	11	9	9	15
Elektr	75	38	62	42	

- 7 Mio dwellings in Poland **(230 kWh/m², 100 Mio MWh, 35 €/MWh, 3.6 bn €)**
- 1.2 Mio dwellings in Czech Republic **(200, 15, 39, 0.6)**
- 0.8 Mio dwellings in Slovakia **(170, 11, 34, 0.38)**
- 0.7 Mio dwellings in Bulgaria **(180, 8, 27, 0.2)**
- 0.4 Mio dwellings in Latvia **(150, 4, 26, 0.1)**

In Poland 2 bn € could be invested in welfare, economic growth, etc instead of dissipating them to the environment if 18.2 bn € (40 €/m²) could be spent

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Objectives (1)

- **contribute to increasing the energy efficiency in social housing by at least 30% on average,**
- **contributing to an overall reduction of about 5% in EU energy use,**
- **main beneficiaries being the inhabitants of social housing**
- **missing innovations in financing refurbishment projects is one of the biggest obstacles to reach EU targets.**
- **East European partners from Czech Republic, Poland, Latvia, Bulgaria and Slovak Republic joint forces with West European partners from advanced countries like the Netherlands and Denmark to develop innovative Tailored Financing Schemes.**

Financing Schemes

- Grants
- Privatisation
- Performance Contracting, Third Party Financing
- Commercial loans
- Soft loans
- Energy Service Companies (ESCO's)
- Investment Funds for Energy Efficiency and Renewable Energy Sources, in particular for small-scale investments e.g. as revolving funds
- Structural funds
- Public participation models with citizens holding shares of RES or RUE investments
- Competition models e.g. between
  - Voluntary Agreements for "green energy" (RES, energy efficiency in buildings, transport and industry)
  - Procurement schemes for RUE and RES investments in buildings, industry and transport

Expected results

- **Working financing schemes**
- **As all organizations are closely related to their government bodies the InoFin project is highly welcome to foster the implementation of the Building Directive by recommendations on adjustment of the national implementing rules.**
- **The InoFin-Team would be glad to remove a crucial barrier mainly from Eastern European markets on building refurbishment supporting job creation in the building industry and faster realization of the member countries obligation to reduce carbon dioxide emissions.**

Work packages

(1) Project management and reporting (CEBra)
(2) Situation in financing social housing refurbishment (ECN)
(3) Design of financing schemes tailored to refurbishment of social housing (ECNet)
(4) Testing tailored financing schemes on various types of projects (SEC)
(5) Design of necessary adjustments to the legal and institutional framework (ECB)
(6) Specific dissemination activities (CEBra)
(7) Common dissemination activities (CEBra)

principally speaking

Seal and insulate!

walls

Fresh air

Used air

exploit!

control!

heat

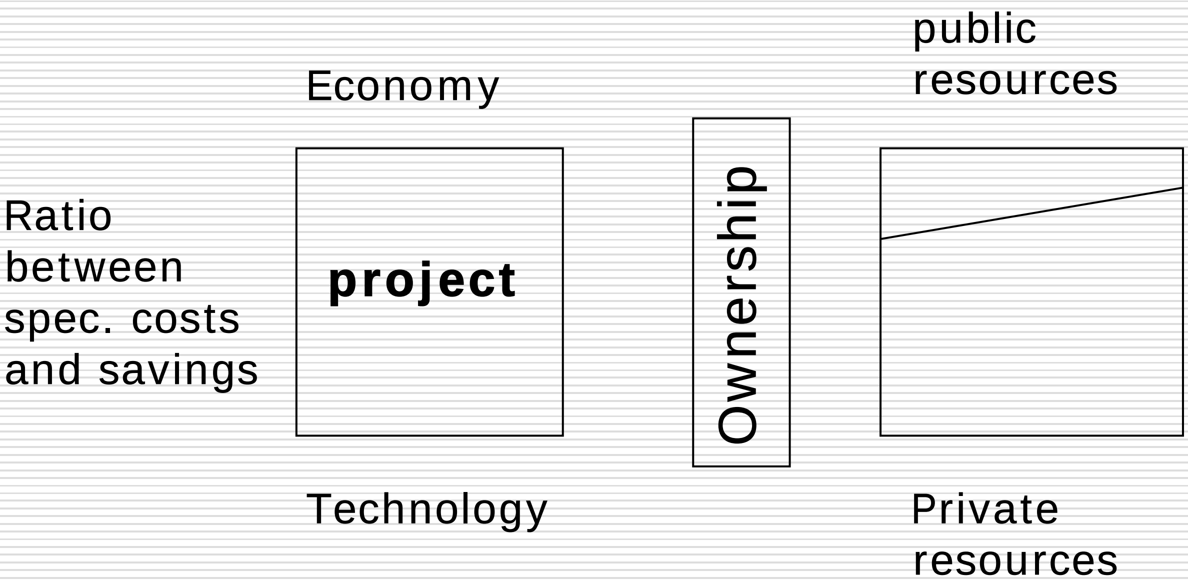
Transmission

reduce!

Technology

substitute! optimize!

Principles found so far



Who should do what?

Public Responsibility

private initiative

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TAILORED FINANCING SCHEMES FOR SOCIAL HOUSING REFURBISHMENT

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Polish Thermo-Renovation Fund

How does the system work?

1. The state budget writes money to the Thermomodernisation Fund – 27,5 million Euros for 2005
2. The commercial banks are spending the Fund's money as the 25% bonus to the loans given to the investors
3. The investor's obligation is to present the energy audit which confirms savings required by conditions set by law

Utilization of the Thermomodernisation fund as of 03.11.2005

- **Number of applications: 5056**
- **4469 positive, 400 negative,**
  - **Single family: 522**
  - **Multifamily: 3780**
  - **Public: 603**
  - **Hostels: 51**
  - **Local heat sources and networks: 98**
  - **Others 2**

- **Main sources of financing come from State budget**
- **The initial capital - 1,25 million €; the current sources of financing allocated to the Fund are equal to 40 million €**
- **Year by year amount and number of extended bonuses are increasing:**
- **In 2002 3 260 000 € 286 bonuses**
- **In 2003 7 576 000 € 668 bonuses**
- **In 2004 14 638 000 € 1 152 bonuses**
- **In 2005 28 934 000 € 1 947 bonuses**
- **In 2006 26 538 000 € 1 706 bonuses**
- **By the end of May 2006, 6 222 bonuses were extended to the total amount of 83,1 million €**
- **For year 2007 there is amount of 64,0 million € planned**

One open Question

- Estimation of needed resources says about 630 Mio EURO when the goals of the system have to be achieved. It means annually 157 Mio Euro during next 4 years. The state plan for next year is just 64 Mio Euro. Since the co-financing of the measures in multifamily buildings by the EU structural fund won't be available in wide range, the needed resources will be to highest probability mobilized by the state budget.
- There is still an open question, how to finance the thermomodernisation of remaining part of housing constructed 1945-1988 e.g. app. 570,000 buildings with 7 Mio dwellings defined for the InoFin project as a target group.

Municipal support with non-interest loan

Valmiera city council provides non-interest loans for dwelling buildings to improve energy efficiency:

- Max. amount of loan is 7,000 EUR
- max length of loan is 3 years
- payback time of energy efficiency measures <4 years.

This is financed from Privatisation funds of municipality.

European Structural funds

Latvian government has taken decision that ~ 43 million EUR from EU structural funds for 2007-2013 will be allocated to energy efficiency projects in housing sector.

This money will cover co-financing costs for

- ~570 buildings assuming that
- co-financing from EU </=75%
- total refurbishment costs </=100,000 EUR per building

Green Investment Scheme (GIS)

WB has been requested by the Government of Latvia to carry out an analysis of options for trading Latvia's surplus Assigned Amount Units (AAU) pursuant to Art.17 of the Kyoto Protocol to the UNFCCC – incl. options for the structuring of pilot Art.17 transactions and options for investing the revenues from such transactions through a Green Investment Scheme.

The money from trade of AAUs is planned to invest in renewable resources projects and energy efficiency projects.

Actors involved

- Latvian government
- Financing of GIS

  WB, EBRD, ???

  consulting institutions
- Commercial banks
- Energy auditors
- Home owner association/condominiums
- Agreement about EE measures
- Energy manager for monitoring
- Verificators

Economic / risk barriers

GIS is planning to provide up to 40% of eligible costs for energy efficiency projects. This will reduce overall costs and will bring better conditions for loan from commercial bank.

Portfolio of buildings has to be prepared to packaged project in acceptable size.

Organizational barriers

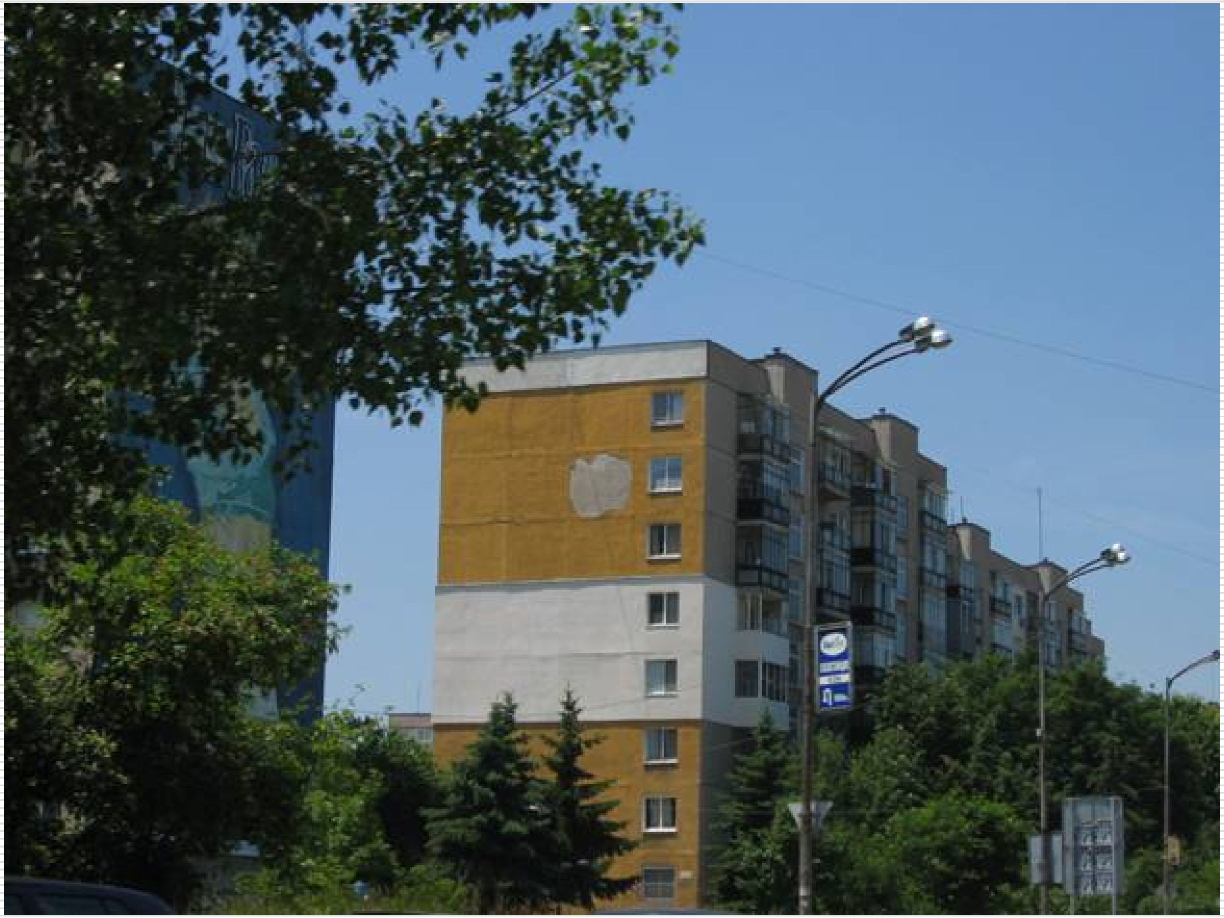
It is not clear about those buildings, which are connected to DH system which is participating in EC ETS scheme. In this case of reduction of energy consumption in buildings DH company will sell allowances.

The Residential Energy Efficiency Credit Line

EBRD extend loans to 4 private Bulgarian banks for on-lending to the residential sector for improvement in energy efficiency both in blocks of flats and individual houses.

Eligible sub-projects include the following energy efficiency improvement:

- **Energy efficient windows;**
- **Thermal insulation on walls, roofs, slabs;**
- **Efficient biomass boilers;**
- **Solar water heaters;**
- **Efficient gas boilers.**



Thank you !

Hope to get in touch for technology transfer and promotion

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Legal structure of “owner”

- **Poland**
- **Czech Republic**
- **Slovakia**
- **Brandenburg**
- **Bulgaria**
- **Latvia**

Factor 4

A sustainable energy strategy for social housings in Europe

Thessaloniki, 8 November 2006

Catherine Charlot-Valdieu and **Philippe Outrequin**
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Grant Agreement EIE/05/076/S12.419636

The Factor 4 project (IEE 2005)

Objectives of the project :

- **To work out an economic and operational tool for social owners in order to favour the integration of energy and GEG challenges in the management plan of their building stock**
- **To recommend technical and non-technical actions to implement energy efficient planning in a comprehensive way between the short term possibilities and the long term issues (reduction of GEG by a factor 4 before 2050).**

Partners :

Association SUDEN (coordinator)

La Calade, HTC (France)

Cenergia (Denmark)

Ricerca e Progetto (Italy)

Promotors Association for Local Development (Romania)

Social owners partners :

Moulins Habitat, and Logicil - groupe CMH, SAGECO – groupe Caisse d’Epargne, Maison Girondine, OPAC 38, UNILOGI... and USH (France)

Volkswohnung (Germany)

KAB (Denmark)

Soc. Coop. ABITA (Italy)

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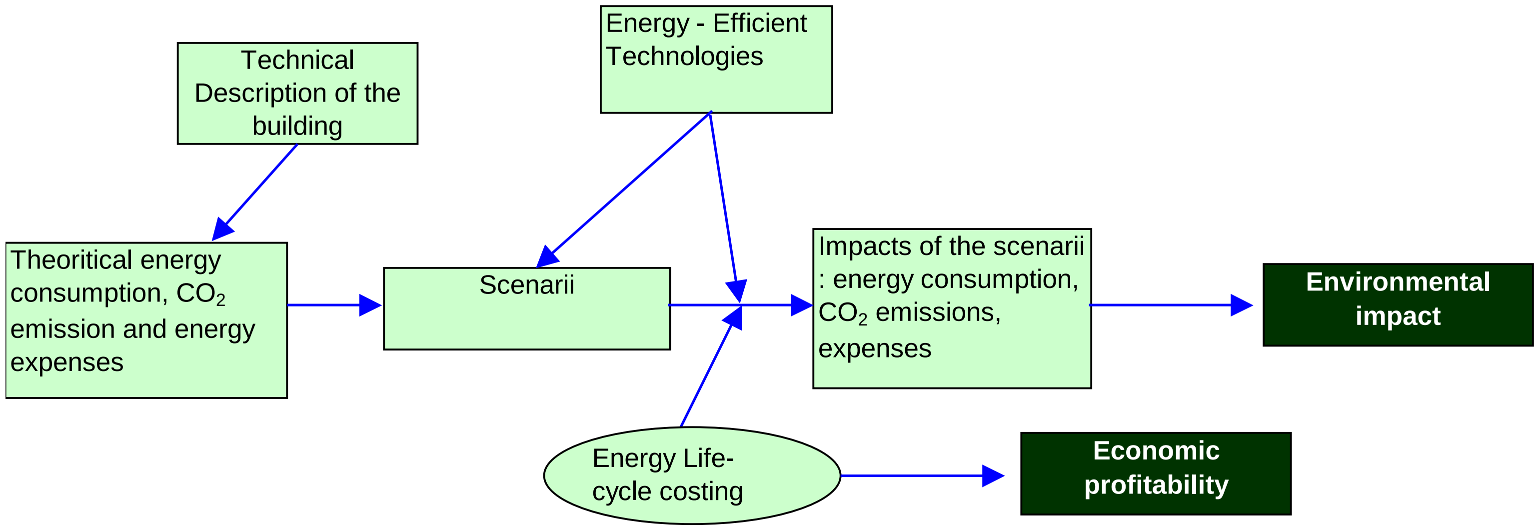
The energy retrofitting of existing social housings : a crucial issue for decreasing GEG emissions

	Social Housing Stock (million dwellings)		Energy consumption (GWh)	CO_2 emissions (mio. Ton)
	2004/2005	« 2050 »	2004	2004
France	4.3	2.7 to 3.0	56 000	11.8 *(20 % of the building stock)*
Germany	1.9	1.4	ongoing	
Italy	0.92	0.92	10 500	2.2 *(30 % of rental housings)*
Denmark	0.51	0.50	4 600	0.6 *(15 % of the building stock)*

Source : Factor 4, IEE 2005

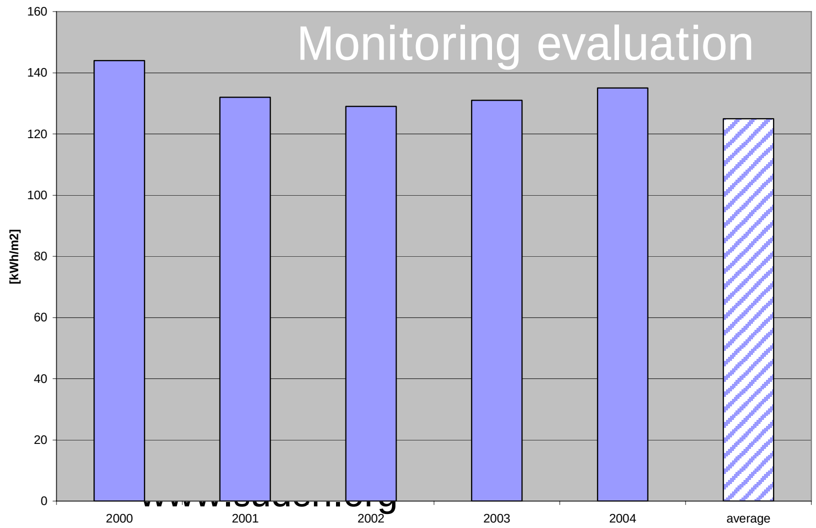
The energy retrofitting of existing social housings : Economical and environmental analysis



The modelling of economic and environmental impacts of energy – efficient projects : ASCOT model in Denmark, SEC model (Sustainable Energy Cost) in France and Italy, EPBD in Germany (?)

The energy analysis of a building (ASCOT and SEC models)

Project ID	**DK1 - Kildevænget**
Year of construction	1958
Size of the buiding project (treated floor area)	35136 m²
Number of dwellings	450
Number of floor levels	3
Building category	Others
Central- or individual heating	Central heating system
Internal distribution	Insufficient insulation
Energy resource (Fuel type)	District heating
Efficiency of the heat production	95%
Reference, electricity	30 kWh/m²
Reference, water inclusive hot water	1.00 m³/m²
Reference consumption hot water	30%
Weather data	
Station	DK, Copenhagen
Building characteristics	
Wall, U-Value	0.60 W/m²K
Roof, U-Value	0.40 W/m²K
Floor, U-Value	0.40 W/m²K
Window, U-Value	3.10 W/m²K
Data for new heating system	
Central- or individual heating	Central heating system
Heating supply system	District heating
Efficiency of the heat production	95%
Economic data	
Investment of reference project	0.00 euro/m2
Set aside (maintenance)	2.5% %
Expected economic lifetime	30.00 years
Discount rate	5.0%
Tax of interest	0.0%
Inflation of energy	2.5%
Inflation of maintenance	2.0%



Economic analysis for energy efficient technologies

Heating	
Passive solar heat design	☐
Ventilation with heat recovery	☑
Airtightness	☑
Energy savings through water saving	
Energy savings / tenant behaviour	☑
Energy efficient windows, U-value=1,4	☐
Super energy efficient windows, U=1,1	☑
Cold bridges, 50% improvement	☑
Additional insulation, 100mm valls	☑
Additional insulation, 100mm roof	☑
Additional insulation, 100mm floor	☑
Improved distribution (insul.+BEMS)	☑
New heating system	☐
Active solar heat, DHW	☑
Sum of chosen initiatives	
Water	
General water conservation initiatives	☑
Water conservation / tenant behaviour	☑
Collection of rainwater	☑
Local bypass of rainwater	☐
Sum of chosen initiatives	
Electricity (lightning)	
Energy efficient lighting	☑
Electricity savings through ventilation	☑
Electricity savings / tenant behaviour	☑
Hard white goods - Grade A	☑
Roofed clothes drying yards	☑
Daylight optimisation	☑
Photovoltage, 5 sqm per dwellings	☑
Sum of chosen initiatives	
Total	☐

Yearly consumptions and savings per m²	Reference	Sustainable	Savings
Heat used for domestic hot water [kWh]	14.0	5.6	59.6%
Space heating	91.9	14.1	84.7%
Losses in distribution	20.0	5.0	75.0%
Losses in production	6.6	1.3	80.4%
Heating and hot water [kWh/m²]	132.5	26.0	80.4%
Electricity [kWh/m²]	30.0	19.5	35.0%
Water inclusive hot water [m³/m²]	1.00	0.38	62.0%
Consumption hot water [m³/m²]	0.30	0.11	62.0%
Yearly emission [kg]			
CO_2	1,397,424	656,926	53.0%
SO_2	3,087	1,931	37.5%
Nox	6,313	3,047	51.7%
Damages of air pollutants in euro per year			16132

Yearly running costs	Reference	Sustainable
heat	329,081	64,612
water	161,204	61,258
electricity	290,926	189,102
Extra maintenance		164,294
Total yearly running costs	781,211	479,265

Economy	
Investment in standard project	0
Additional investment	6,509,530
Total	6,509,530
Total per dwellings	14,466
Total per sqm. Treated floor area	185
Investment per kg CO_2 reduction	8.79
Simple Payback Time, years	21.6
Net Present Value	83,958
Profitable investment	

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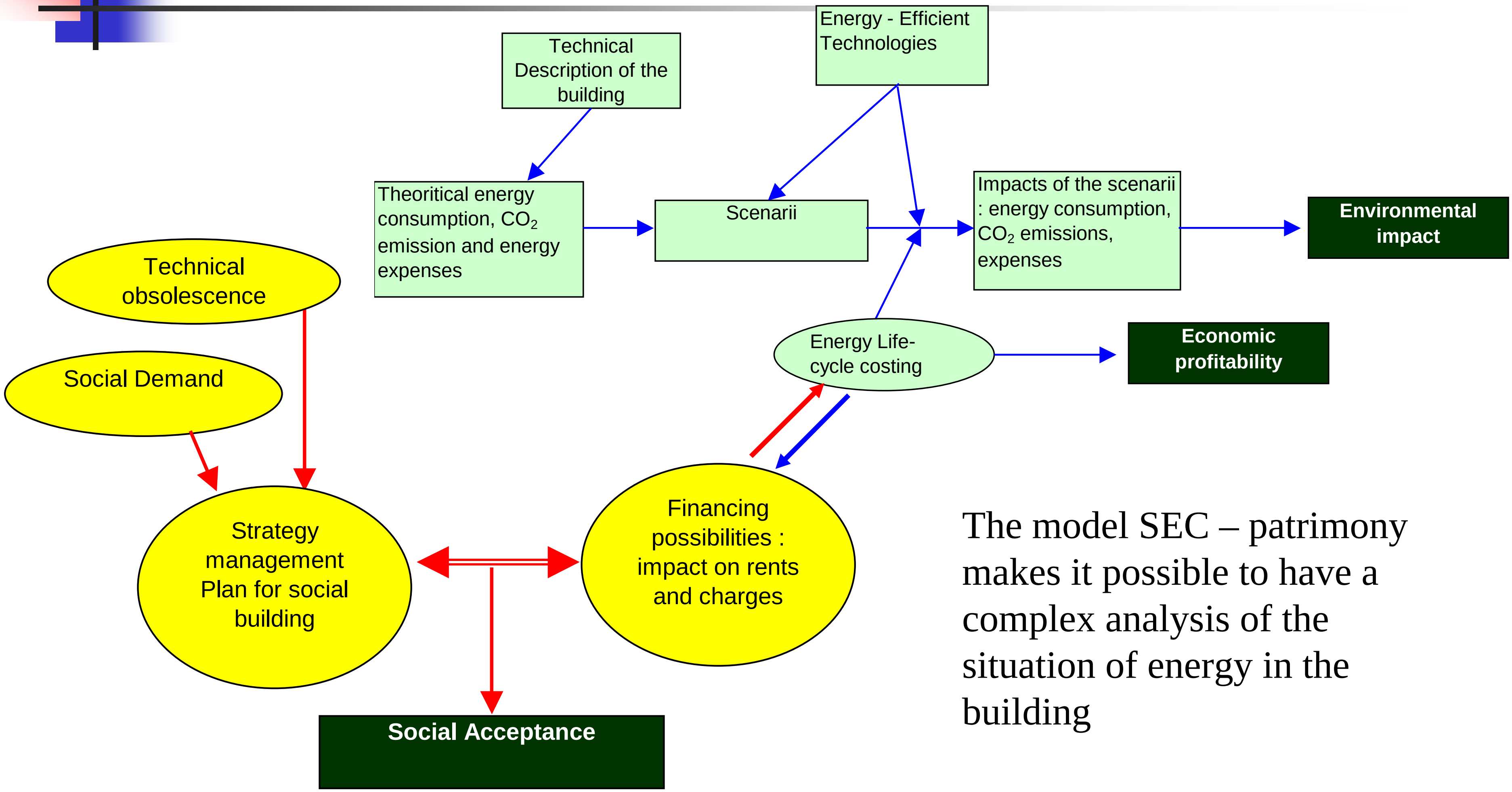
The energy retrofitting of existing social housings : Social impact and sustainability



The model SEC – patrimony makes it possible to have a complex analysis of the situation of energy in the building

Equipement	présence dans le bâtiment	Année de remplacement
	1 pour oui	année
1 - INTERIEURS DES LOGEMENTS		
Chauffe eau / chauffe bain		
Convecteur gaz		
Chauffage électrique		
Canalisations radiateurs	1	2008
Electricité	1	2008
Meuble évier	1	2008
Sanitaire équipement porcelaine	1	2008
Carrelage sol	0	
Revêtement de sol PVC	1	2008
Sanitaires / canalisations	1	2008
Tableau électrique	0	
Ventilation mécanique contrôlée	1	2008
2 - PARTIES COMMUNES		
Eclairage		
Electricité	1	2008
Faux plafonds		
Interphonie, contrôle d'accès	1	2008
Portes palières		
Portes locaux techniques		
Portes des caves		
Portes intérieures		
Peinture	1	2008
Carrelage sol		
Revêtement de sol PVC		
Tableau électrique	1	2008
Ventilation mécanique contrôlée		
Vide ordure		
3 - CLOS ET COUVERT		
Couverture Tuile collectif		
Descente eau pluviale		
Couverture Tuile		
Etanchéité terrasse multicouche	1	2008
Fermeture volets		
Garde corps		
Imperméab./peinture/traitement/ravalement	1	2008
reprise maçonnerie façades	1	2008
menuiseries alu collectif		
menuiseries maison individuelle		
menuiseries PVC collectif		
Porte entrée immeuble	1	2008
portes garage individuel		
Porte entrée logement individuel		
Peinture		
Etanchéité terrasse MI		
4 - GROS EQUIPEMENT SUR CONTRAT		
Ascenseurs - cabines		
Ascenseurs - motoréducteur		
Ascenseurs - opérateur		
Ascenseurs - serrure		
Ascenseurs - variation fréquence		
Porte parkings		
Chauffage - Colonnes	1	2008
Production chauffage collectif		
Chauffage - réseau enterré		
Chauffage - sous station		

The SEC – Patrimony model

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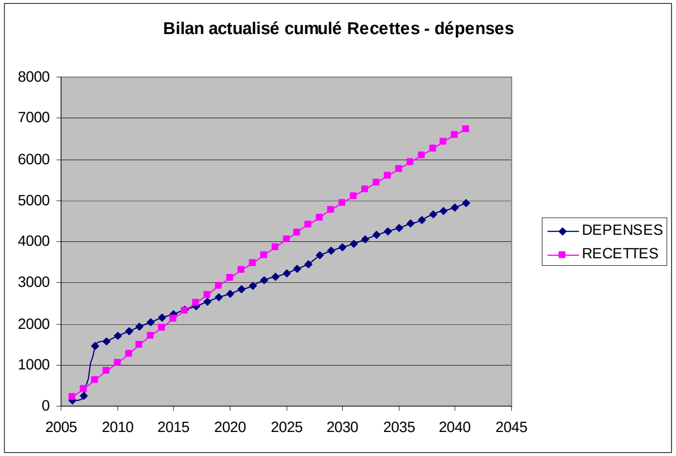
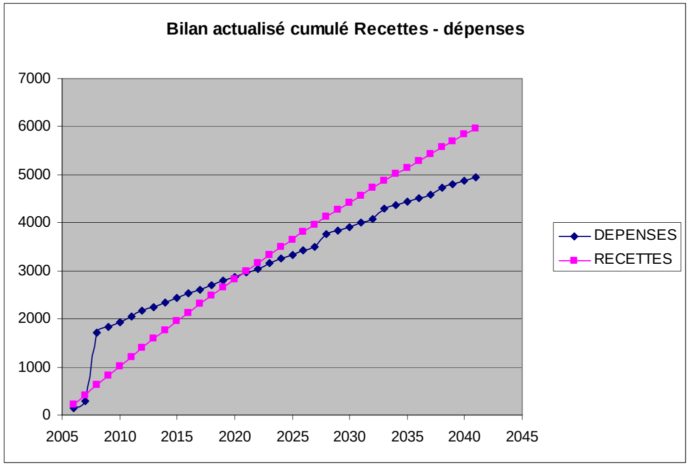
The energy analysis of a building





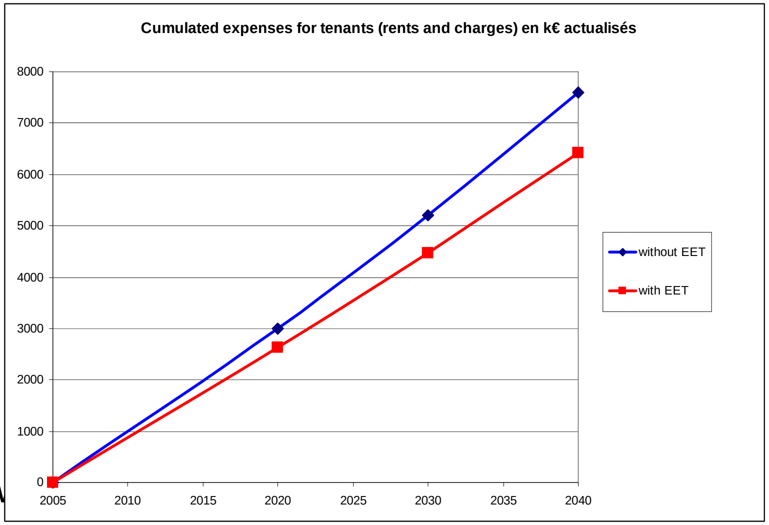
Energy Efficient Technologies (EET) project :

- Roof insulation

- High yield boiler

-Solar hot water

- High perfomance windows



The shared LCC in the new construction : the SET – SHE model (SHE project, www.she.coop)

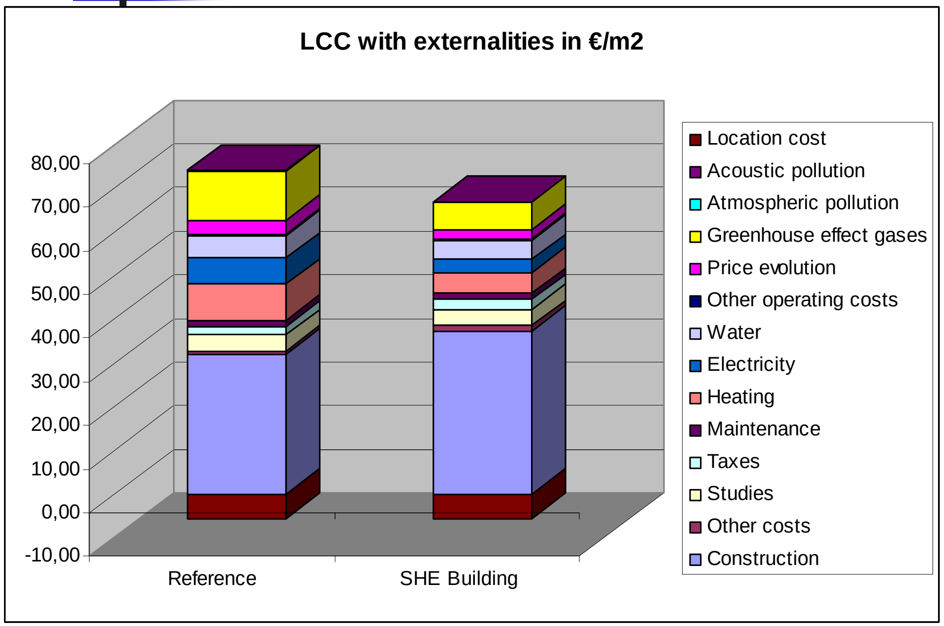
Shared Life-Cycle Costing :

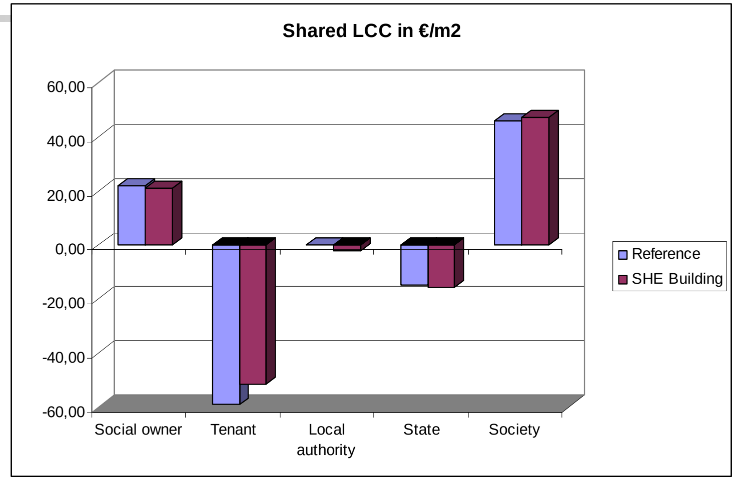
- Direct Cost = investment + operating cost
- Externalities : GEG, acoustic pollution, location of the building / services and equipment...
- Shared cost between the different stakeholders
- Qualitative indicators for a global approach

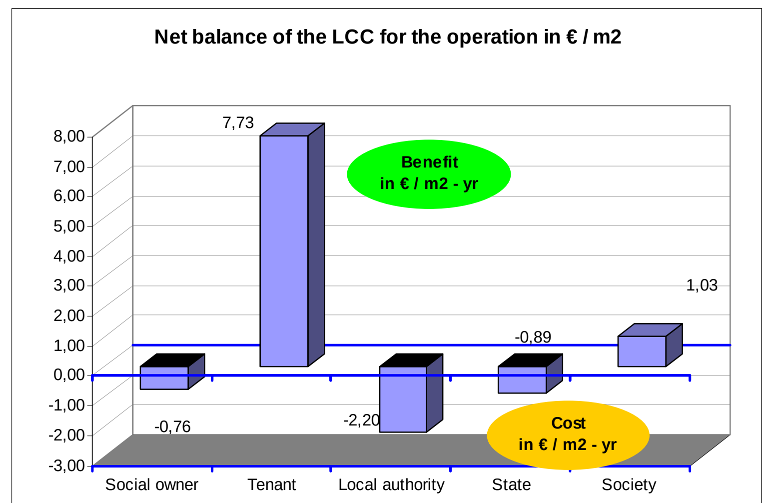


5 Italian cooperatives, 3 social owners in France, Portugal and Denmark

The shared LCC in the new construction : the SET – SHE model (SHE project, www.she.coop)







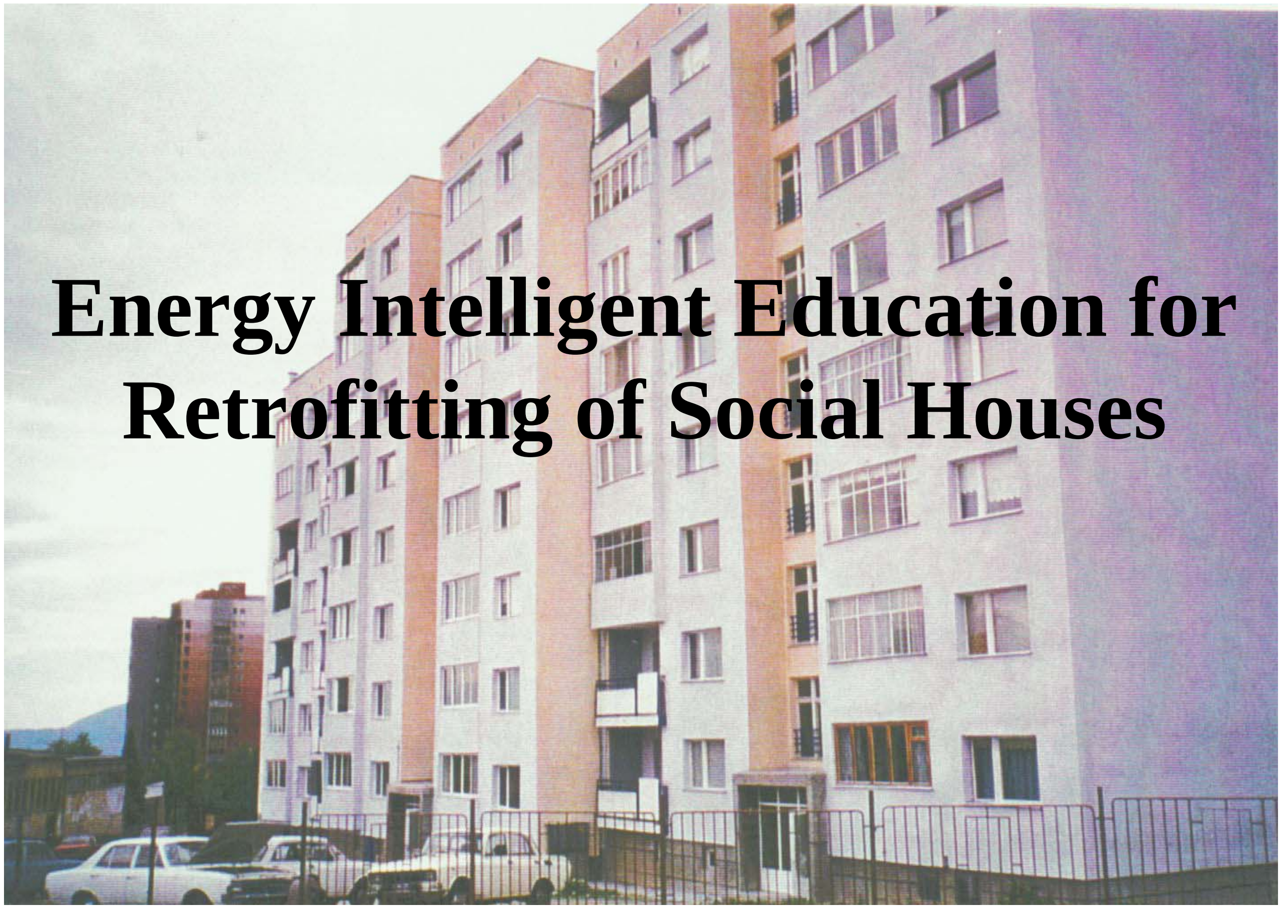
OPAC 38 Project :

construction of 40 dwellings

Conclusion
the Factor 4 objectives

- To work out **operational** models, **adapted** to each national context, **easy to use** by social owners in order to make themselves (able to) take into account energy efficiency and GEG emissions **in their strategic management plan for their whole building stock**
- These models should be also **decision aid tools** for each building retrofitting when necessary
- Factor 4 and its models are also an help for the implementation of integrated strategies and new ways of working **towards urban sustainability**, in synergy and coherency with other tools (SET-SHE, the European Directive about eco-design...) or approaches (HQE2R)

Energy Intelligent Education for Retrofitting of Social Houses



The main objectives of El-Education project are to:

- Give the social housing companies and municipalities knowledge and tools to perform energy efficient retrofitting in form of an education programme and

- Prepare a guidebook with best practical examples, ideas and checklists.

Partners in the project are:

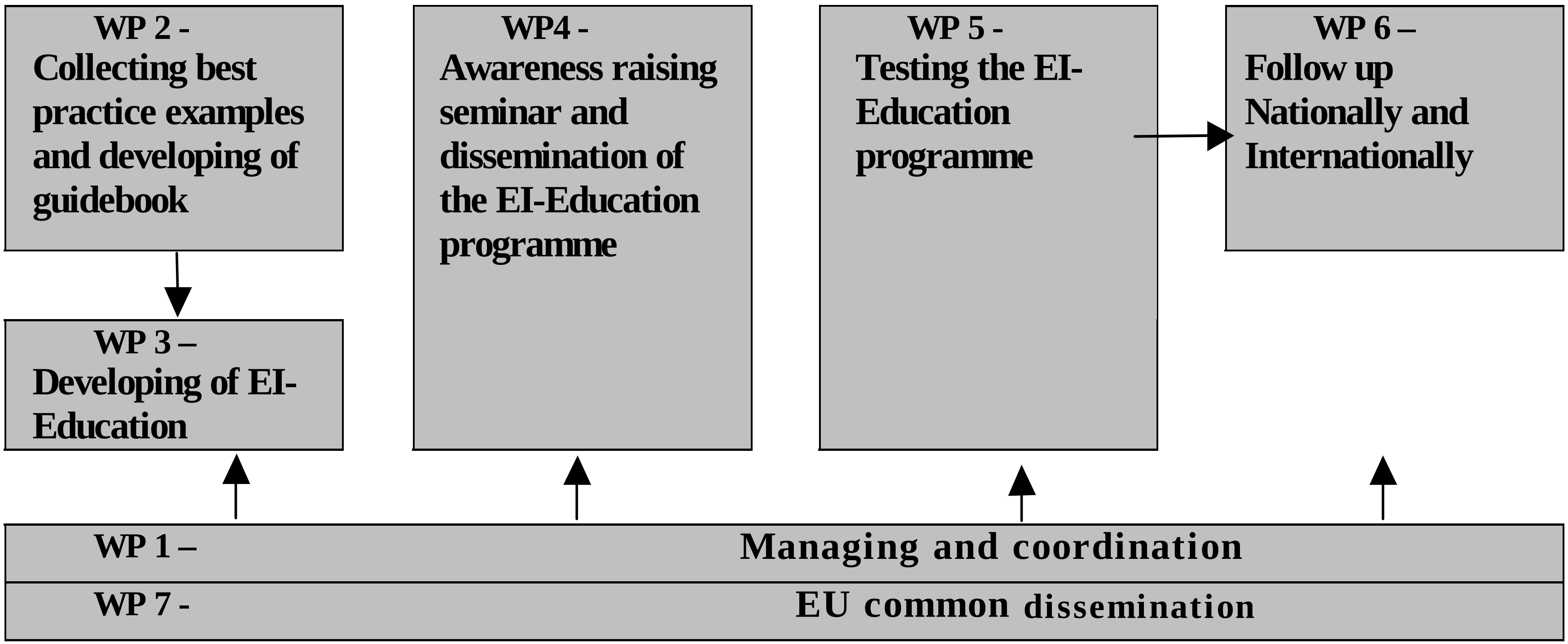
- Aarhus School of Architecture, department for Supplementary Education (AAA), coordinator – Denmark;
- Energy research Centre of the Netherlands (ECN), the Netherlands;
- Cenergia Energy Consultants (Cenergia), Denmark;
- O.Oe. Energiesparverband (ESV), Austria;
- Centre Scientifique et Technique du Bâtiment (CSTB), France;
- Sofia Energy Centre (SEC), Bulgaria;
- Building and Civil Engineering Institute ZRMK (BCEI ZRMK), Slovenia;
- National Association of Housing Companies in Denmark (BL), Denmark;
- Housing Fund of Ljubljana (HF LJ), Slovenia;
- Development, Etudes pour le Logement, la Promotion de l'Habitat, l'Innovation et le Social (DELPHIS), France.

Intelligent Energy Europe

Description of work:

- **An El-Education programme for social housing companies, including a practical guidebook** is under elaboration to motivate and educate them on how to perform energy saving measures. The programme has its base on the best practice projects on energy efficient retrofitting in Europe.
- Implementation of the El-Education programme by organizing **national training courses** for social housing companies in 6 countries.
- **An awareness rising seminar** for Housing Associations will be organized under the auspice of CECODHAS, the European Liaison Committee for Social Housing and inviting ECTP (European Construction Technology Platform).

Structure of the work programme



Content of the guidebook

Chapter 1: Status quo of renovation (common practice) and needs for innovation and education in the partner countries

Chapter 2: Why to renovate – needs of refurbishment and high energy consumption in social housing

Chapter 3: When to renovate – organisational and financial preconditions

Chapter 4: How to renovate - In the guidebook the 10 most important elements of saving energy will be described

Chapter 5: Checklists and tools

Chapter 6: Best practice examples - The guidebook will describe 5-10 best practice examples from each region – from technical, financial and from organizational point of view, demonstrating that it is possible to increase the energy efficiency in social houses by retrofitting by at least 30%.

Chapter 7: Recommendations to overcome barriers and support drivers.

Best practice from Bulgaria

Block №10, district Zaharna Fabrica, Sofia. The multi-dwelling building was constructed in 1947 with 1100 m^2 living area (13 dwellings) and renovated in 2004.

The renovation includes:

- Thermal insulation of external walls;
- Whole reconstruction of attic;
- Water proofing and thermal insulation of roof;
- Thermal insulation of basement ceiling;
- New double glazed windows with PVC frames;
- Improvement of heating system.

The costs of the renovation were 104 750 BGN (approx. 52 375 euros)

Building before renovation

Energy saving - 46%

	Energy consumption (in KWh/m^2 per year)	
	Before	After
Heating	162.6	60.2
Hot water	30.5	43.8
Int. Ch.	194.7	105.6

Refurbished building

Lessons learned and conclusions:

- ✓ **For the realization of refurbishment of a multi-dwelling building in Bulgaria it is necessary to involve all owners and to organise them in an association;**
- ✓ **The costs of refurbishment can be, at least partially, covered by an extension of the building.**

Best practice from Geneva (Switzerland)

Low rent residential building, rue de Lancy 1-3, Carouge, Geneve.
The apartment building was constructed in 1953 and renovated in 2005. The building has total floor area of 3845 m^2 and 62 dwellings.
The owner is "Fondations Immobilières de Droit Public" (housing association).
The renovation is financed by the owner.

The renovation includes:

- Roof, façade and floor insulation;
- High efficiency insulation of glazing and frames;
- High efficiency boiler;
- Low temperature heating;
- Controlled natural ventilation;

Building before renovation

Energy saving - 80%

Energy consumption before renovation was 214 kWh/m^2 and after is 42 kWh/m^2 (for heating and domestic hot water)

Lessons learned and conclusions

- ✓ **This project proves that even buildings with limited refurbishment budgets can afford high energy performance and indoor environment quality.**
- ✓ **High energy performance means also high building quality.**
- ✓ **High energy performance does not necessarily mean complex, expensive and exotic technical installations. It can also be achieved by robust conventional solutions.**

Building after renovation

Some preliminary conclusions from the best examples

- The comparison between the retrofitting models in different European regions is extremely important.
- The increase of the energy efficiency in the presented examples ranges from 25% to 94%. The average value is 50%.
- The renovation of a building aimed at increasing the energy efficiency can be done both in old and in new buildings.
- The cost of renovation in Euro per m^2 varies in wide range.

Some preliminary conclusions from the best examples

The cost for renovation depends on:

- **Whether the measures applied are for energy efficiency only or for renovation of the building in general;**
- **The number of different measures taken;**
- **The characteristics of the suggested measures (traditional or ones requiring high technologies);**
- **The standard of living in the country.**

Main refurbishment measures

The main conventional measures taken can be divided in the following types:

- **High envelope performance, including:**
  - Insulation of façades, roof, top ceiling, ground floor;
  - Double glazed windows with PVC frames;
  - Renovation of the balconies and the entrances.
- **Improvement of the heat systems**
  - Insulation of distribution pipes;
  - Management and control system;
  - Installation of heat meters and heat valves;
  - New energy-efficient boiler.
- **Installations**
  - Mechanical ventilation with heat recovery.
- **Renewable energy sources**
  - Solar thermal collectors;
  - PV-systems.

Lessons learned and conclusions from the best examples

- **Austria**
  - It is worthwhile to involve and inform the occupants well and to listen to their wishes and proposals and, where possible, to fulfill some of them.
  - New buildings in GIWOG (social housing association) should be equipped with mechanical ventilation from now on.
  - The energy saving potential is very high but is dependant also on the user behaviour, especially with the new windows and installed outside walls.
- **Bulgaria**
  - For the realization of refurbishment of an apartment building in Bulgaria it is necessary to involve all owners in an association.
  - The implemented insulation of external walls, roof and basement are cost-effective.

Lessons learned and conclusions

- **Latvia and Lithuania**
  - It is very important to involve all occupants in the process of refurbishment.
  - A flexible financing scheme would help for a better implementation and better results.
  - The availability of grants, soft loans and flexible credits is necessary for the realization of projects for renovation of multi-dwelling buildings.
  - The role of the municipalities is very important for the implementation of a wide-scale social housing refurbishment.

- **Denmark**
  - PV modules are efficient.
  - The individual heat recovery ventilation system has performed well and contributed to a much improved indoor air climate.
  - Solar low energy retrofit projects are among the most important in the housing sector in Denmark.

Lessons learned and conclusions

- **France, Germany and Switzerland**
  - The improvements of the apartment buildings increase their quality and the living comfort.
  - Balanced ventilation with heat recovery can be achieved even if interior interventions must be avoided.
  - Solar thermal panels for DHW and PV for pumps, ventilation and lightning are good solutions.
- **The Netherlands**
  - The effort to communicate with tenants has contributed to a final success.
  - The total living costs after the renovation cannot increase.

Thank you

for

Your attention!

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