

**This report includes summaries from 4 separate demonstration projects for energy efficiency retrofit implemented in residential buildings in Bulgaria**

**Demonstration project for energy efficiency retrofit of Residential building “T. Venkova Street” , bl. 11 ,13,15,17 and 19 in the framework of GEF Project No. BUL/96/G31/A/1G/99 -"Energy Efficiency Strategy to Mitigate GHG Emissions. Energy Efficiency Demonstration Zone in Gabrovo, Republic of Bulgaria"**

**Executing Agency: Centre for Energy Efficiency EnEffect, Sofia**

**(Abstract)**

Project hosts are residents and *Toplofikatsiya Gabrovo*. A residential panel apartment building in the city of Gabrovo was selected for this demonstration project. The apartment building has been commissioned in 1986 and comprises five entrances of 6, 7 and 8 floors respectively. The building has been constructed using a standard-model design, typical for the panel buildings construction in Bulgaria. The building is district heated via 3 indirect sub-stations., No domestic hot water has been supplied in recent years. The total number of apartments is 108.

The evaluation team made a number of thermographic snaps for the characteristic of certain building elements. The pictures have proven that the major portion of the heat losses from conduction and infiltration are due to the glazed openings and the existence of thermal bridges.

The potential of the energy saving measures was evaluated on the basis of the energy consumption under the "normalized" baseline. Long term monitoring supported by temperature datalogers and heat and electricity meters data observation was conducted after the implementation of energy conservation measures. The results were calibrated over the climate data, heat supply and space use and averaged for 2 heating seasons (years 2000-2002).

The normalised energy consumption in the demonstration building at “T Venkova” Str. No. 11,13,15,17,19 is

**1 056 MWh/year** (908.54 Gcal) for district heating and **236 MWh/year** for electric power.

According to the monitoring results there is profitable Energy Saving Potential for the building:

- **Profitable energy savings**                      **287 500**                      **kWh/year (22%)**
- **Net savings**    **5 554**    **USD/year**
- **Total investments**                                      **18 960**                                      **USD**
- **Total profitability**    **3,4**    **years**

The energy potential for each ECM obtained is summarized in the following table:

Energy Saving Potential					
Building: Res. building Gabrovo			Project: Res build Gabrovo		
Energy conservation measures	Investment [USD]	Net saving [kWh/year]	[USD/year]	Payback [year]	NPVQ
1. Reconstruction of the substations - automation and control with temperature setback and installation of thermostatic valves on radiators	8 618	123 000	2 239	3,9	0,63
2. All windows weatherstripping and main	6 419	117 500	2 138	3,0	1,09

entrance doors replacement					
3. Installation of reflecting screens behind radiators	2 100	20 000	364	5,8	0,09
4. Installation of energy saving shower heads and CLL	1 823	27 000	813	2,6	1,80
<b>Total ECM package</b>	<b>18 960</b>	<b>287 500</b>	<b>5 554</b>	<b>3,4</b>	<b>0,84</b>

Energy prices	USD/MWh
Heat energy	18.20
Electricity	33.10

Profitability parameter		
Total investment	18 960	USD
Net savings	5 554	USD / year
Pay-back	3.4	years
Net Present Value	15 912	USD
Net Present Value Quotient	0,84	
Internal Rate of Return	27	%

**Conditions:** *Real interest rate* = 9.5%  
*Economic lifetime* = 10 years

**Project PSO99/BG/4/10**  
**Energy Efficiency at End-Users of District Heating in Bulgaria**

**Executing Agency: Ameco Environmental Services in consortium with PEJA International B.V., Consultant Energy Production Systems (CEPS) from The Netherlands and its partner from the Bulgarian side is the Centre for Energy Efficiency EnEffect, Sofia.**

(Abstract)

**General information**

Project hosts are *Toplofikatsiya Pleven* Joint-stock Company (District Heating Pleven), respectively residential and municipal sites and the Municipality of Pleven in its capacity of host-authority and owner of part of the sites. Measures were implemented at six Residential buildings with a total 446 apartments, one school, one nursery and one art gallery.

**Demonstration of equipment, activities and procedures for energy conservation**

The selected demonstration residential site is a group of **4 demonstration** (“*Burja*”, “*Uragan*”, “*Spartak*”, “*Georgi Kochev*”) + **1 reference** (“*Neophit Rilski*”) identical 16-stock apartment buildings having a total of 320 apartments and constructed under the "sliding shuttering" technology with brick partition walls. Each apartment building has two independent substations. In 1997 the substations of all apartment buildings were equipped with new modern equipment with management and control devices. The other residential demonstration site – apartment building at “*Ivan Vazov*” Str. No.50 –60 is a 7-stock solid-frame apartment building, consisting of six sections with three substations and a total of 126 apartments.

The project involves several public buildings as well.

### Energy conservation measures in the residential buildings

The measures selected for implementation comprised:

- Fitting of individual heat allocators on the radiators;
- Fitting of thermostatic valves on all radiators;
- Fitting of reflecting screens of aluminum foil behind the radiators;
- Weather-stripping of the joinery;
- Thermal insulation of the pipelines for domestic hot water and re-circulation;
- Fitting of water-saving shower heads in all flats.

One of the five typical apartment buildings, *Neophit Rilski*, was left as a reference site and the measures were applied to it in April-May 2001 in order to use it as a benchmark for the achieved savings. The distribution of the consumed heat in it was carried out on the basis of the heated space volume, while in the other sites - on the basis of heat accounting.

### 4+1 identical buildings

The comparison of the performance of the four typical residential apartment buildings with the fifth reference building since the beginning of the year 2000/2001 heating season reveals material savings to the amount of 30%. These are the buildings with the names: “Burja”, “Uragan”, “Spartak”, “Georgi Kochev”, “Neofit Rilski”. The heating energy consumption in the four buildings was compared with the reference building “Neofit Rilski”. Table 1 shows the heating energy consumption of all five buildings for winter season 2000/2001. The savings of heating energy of 628 MWh at average 36% economy represent very good results for this project .

**Table 1: Consumption of heat energy read by main heat meter in MWh**

Object	Total for period	Difference in comparison with the reference building	% decrease in comparison with the reference building
“Buria”	390	198	33,7
“G. Kochev”	432	156	26,5
“Uragan”	426	162	27,6
“Spartak”	476	112	19,0
“N. Rilsky”	588	<b>reference building</b>	

Total decrease of energy for all four buildings 628 MWh

In the situation as it existed before the demonstration project, the possibilities for decreasing energy consumption otherwise were limited, because of the lack of individual measurement equipment and regulation of energy consumption.

### Building “Ivan Vazov” No.50 –60

The construction of this building is different from the others. Therefore, comparison with the reference building is not possible. For evaluation of the achieved results it is therefore necessary to compare the energy consumption from the demonstration period with that from the previous one. However, in this case corrections should be made for differences in weather conditions.

Table 2 shows the same data corrected for outside temperature. It is clear that the decreasing of energy consumption for heating is over 25%. If we make an analogy with the first group above, we can see the same influence degree of turned off radiators and should be expected a decreasing of 40-45%.

**Table 2: Consumption of total heat energy in MWh for building “Ivan Vazov” during heating seasons 1999/2000 and 2000/2001, adjusted for monthly average outside temperature.**

Address	1999 / 2000	2000 / 2001	Difference for season in MWh	%
	Total consumption	Total consumption		
50 52 “Ivan Vazov” Str.	235.39	176.51	58.88	25
54 56 “Ivan Vazov” Str	228.14	166.52	61.82	27.1
58 60 “Ivan Vazov” Str	261.66	196.02	65.64	25.1

A considerably improved room temperature level has been noted in all premises, and particularly in the students hostel of the vocational high school. The parameters of domestic hot water have also been improved to comply with the requirements

The payback reported of the implemented measures is about 3 years.

**Projects for Energy Efficiency Improvements in Existing Buildings:  
Summarised Results of Measures Implemented in the Building Envelope within  
PHARE Projects BG 9307**

**“Demonstration Project for Energy Efficiency in Multi-dwelling Houses with  
Individual Heating”**

**Executing Agency: Consortium consisting of EXERGIA S.A. Greece, Enrgoproekt Plc., Bulgaria, ICEU, Germany, Energy Centre Sofia.**

(Abstract)

**Demonstration project in Radomir**

The project was executed in a complex of 6 standard pre-fabricated panel type buildings in the town of Radomir, Bulgaria. After a detailed assessment of alternative solutions, it was decided to implement a number of thermal retrofitting interventions in **three** of the six selected buildings. The total cost of the interventions, including the metering devices, amounted to 180 000 ECU.

The following measures have been implemented for improving energy performance of the building shell:

- Exterior wall insulation has been implemented in three buildings using extruded polystyrene board. The insulation boards on external walls have been glued to the old plaster and nailed with plastic couplings, then a thin layer of plaster and a fibre-glass grid (for reinforcement of the plaster), external layer of plaster with special additives for elasticity and final finishing have been applied.

- Thermal insulation and water proofing of the roof;
- Thermal insulation of the basement ceiling
- Restriction of air circulation in the joints between buildings;
- Carpentry replacement (wooden windows and doors) with aluminum ones in one of the demo buildings;
- Repair of existing wooden carpentry in two of the buildings;
- Replacement of the main entrances
- Thermal insulation and glazing of balconies in one of the demo buildings (where carpentry replacements was executed)

Complete central space heating systems with twin diesel oil boilers, central and local automatic controls and heat cost allocation units have been installed in two buildings. A third building was supplied with electric heat accumulators, while more than 100 apartments throughout all the buildings were equipped with electric water heaters. Energy calculations and measurements proved that the demonstration interventions result in 45-50 %energy savings. The payback period of the interventions, under the current energy prices, is 5 to 10 years, at a comfort level as per the Bulgarian norms. As a result of the above measures the thermal characteristics of the buildings have been significantly improved and the inhabitants have enjoyed increased thermal comfort in comparison with the non-insulated buildings. It should be noted, however, that the implemented measures are relatively expensive.

#### **THERMAL RETROFITTING WORK OF THE “BUILDING ENVELOPE”**

<b>Total Unit Cost</b>	<b>(ECU/ m2)</b>
Thermal insulation of exterior walls (facade)	<b>23.5</b>
Water proofing of the second external roof slab	<b>14.0</b>
Thermal insulation of the internal roof slab	<b>6.3</b>
Basement ceiling insulation	<b>14.9</b>
Windows (carpentry) replacement	<b>129.8</b>
Repair of existing wooden carpentry	<b>8.5</b>
Replacement of main entrance doors	<b>54.0</b>
Thermal insulation and glazing of balconies	<b>60.0</b>

It's evident, that the highest is the price of windows-carpentry replacement - 129,8 Euro/m2 (pay-back period of about 20 years), but it is a measure that can be individually applied, while thermal insulation on the external walls costs 23,5 Euro/m2 with a pay-back period of about 8 years, but its application requires the agreement of all co-owners of the building. The average pay-back of the building envelope measures is about 9 years. The economic calculations have been made based on 1998 prices in Bulgaria.

#### **“Demonstration Project for Energy Efficiency in Multi-dwelling Houses with Central Heating”**

**Executing Agency: Consortium consisting of Haskoning S.A. Netherlands, Enrgoproekt Plc., Bulgaria,.**

#### **(Abstract**

##### **Demo project in Plovdiv**

The project was executed in an 8-floor pre-fabricated panel type apartment building (6 entrances) in town of Plovdiv, Bulgaria. The building is district heated via 3 substations.

The following measures have been implemented for improving energy performance of the building:

- Replacement and automation of the substations and heat-meters installation
- Installation of thermostatic valves and heat allocators
- Exterior wall insulation.
- Thermal insulation and water proofing of the roof;
- Thermal insulation of the basement ceiling
- Repair of existing wooden carpentry and weatherstripping
- Thermal insulation and glazing of balconies

The following measures have been implemented for improving energy performance of the building shell:

<b>Energy saving measures</b>	<b>Savings %</b>
Thermal insulation of exterior walls (facade)	<b>4.9</b>
Thermal insulation of the roof	<b>4.7</b>
Thermal insulation of basement ceiling	<b>2.4</b>
Repair of existing windows in flats	<b>17.6</b>
Thermal insulation and glazing of balconies	<b>2.3</b>
Repair existing windows in staircases	<b>0.5</b>
<b>Total</b>	<b>32,4</b>