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"Improving Energy Efficiency in Buildings" UNDP-GEF/00059937 project

Demonstration of Energy Efficiency Measures in Multi-apartment Social Building, Goris town of Syunik Region

"Improving Energy Efficiency in Buildings" UNDP-GEF/00059937 involves a component on integrated building design approach advantages demonstration that aims to show its energy and cost efficiency potential via its application to selected pilot multi-apartment buildings.

Among others, the multi-apartment social building constructed on 151 Mashtots str. in Goris town of Syunik region was selected as a pilot. The three-storey building's total area is about 950m^2 (including 20 apartments and basement). It is constructed in the frames of "Social housing with availability of supporting conditions Goris-2" project implemented jointly by the RA Ministry of Labor and Social Affairs, the RA Ministry of Urban Development, Syunik region administration, Goris town administration and Swiss Development and Cooperation Agency.

With the purpose to implement activities aimed at improvement of energy efficiency, three-lateral Letter of Intent was signed between Syunik marz administration, Swiss Development and Cooperation Agency and UNDP Armenia on June 30, 2011.

According to the Letter of Intent, construction of the three-storey building with a total area of 950 m^2 was performed as set forth by the revised (project) version of the baseline design. The project design considered energy efficiency measures and involved changes in the building envelope, basement and last floor covers, doors and windows aiming at improvements in their thermal and technical characteristics via application of modern technologies and materials. For insulation, two-component blown polyurethane technology was selected. The material has internationally recognized certificates of conformity (sanitary, fire and energy performance). Besides, it was tested in a respective local laboratory.

Performing the assumed obligations according to the Letter of Intent, the UNDP-GEF project experts monitored the construction works in Goris town of Syunik marz on a regular basis. In particular, the project's experts consulted insulation works of the building's external walls, columns, lengthwise and widthwise beams and floors. The experts also supervised other works that had a potential impact on energy performance of the building.

The walls are 300mm-thick with 150mm of basalt masonry and the other 150mm – of monolith reinforced concrete insulated from inside by a 60mm thick, on-site-blown polyurethane layer.

From the inside, polyurethane was covered with 100mm thick concrete blocks. Basement and the last floor covers were insulated with 40mm of polyurethane layer, covered with steel mesh and 40mm of concrete. The installed energy efficient hermetic windows and doors further enhanced energy efficiency of the apartments.

In the scope of the Project heat allocators were installed in all apartments for monitoring the actual heat consumption. Energy efficient bulbs (CFL) that use at least 4 times less energy and have a longer life-time cycle compared to regular bulbs were installed in all apartments and entrances of the building. The entrances and staircases were also equipped with automated lighting system. Water meters were installed in all apartments to monitor hot tap water consumption.

Air inlets were installed on the building's windows to ensure sufficient ventilation of the apartments, avoid temperature fluctuations and ensure stable temperature in the building.

The heating and hot water supply in the building is provided through centralized heating system (gas based local boiler), the boiler is installed on the roof of the building.

The incremental cost of energy efficiency measures was estimated at 9% of the baseline cost of the building construction. As a result of the implementation of energy efficient measures the energy costs for the residents will decrease by more than 50% at the same time ensuring improved living conditions in the apartments.

The official opening of the Pilot building took place on December 18th. The keys of the new apartments were handed over to twenty families selected by the special committee as the beneficiaries of the project.

During the building's energy performance assessment, the following activities were implemented:

- Readings of the apartment-level hot water and power meters, as well as of the allocators installed on the apartment radiators were recorded/documented;
- Readings of the building-level natural gas, power and water meters were recorded/documented;
- Within the study (from January 15 to March 1, 2013), temperature and relative air humidity metering and recording mobile data loggers (total 52 devices, see Figure 1) were installed in the building's apartments, common/shared areas and outdoors. The obtained record enables a sampling and a respective estimation of the average air

temperature as well as the average relative air humidity and the dew point in various sections of the building;

- To obtain the actual pattern of heat loss from the building's envelope, Testo 875-2 infrared camera was used to produce the envelope's thermal shots. For qualitative assessment of the surface temperature, color scale in the upper right corner of the photos can be used (Figure 3).

Figure 1. Temperature and relative air humidity data loggers.

A graph of the average values of the data collected of apartments and stairwells is presented in Figure 4.

Consumption metering of all the energy carriers (power, hot water, heat) is performed on apartment level.

The said study reveals that apartment space heating prevails in the annual balance (44%) followed by the common/shared areas heating (23%) and hot water supply (22%). Food preparation, lighting and domestic devices sum up to 11% (Figure 2).

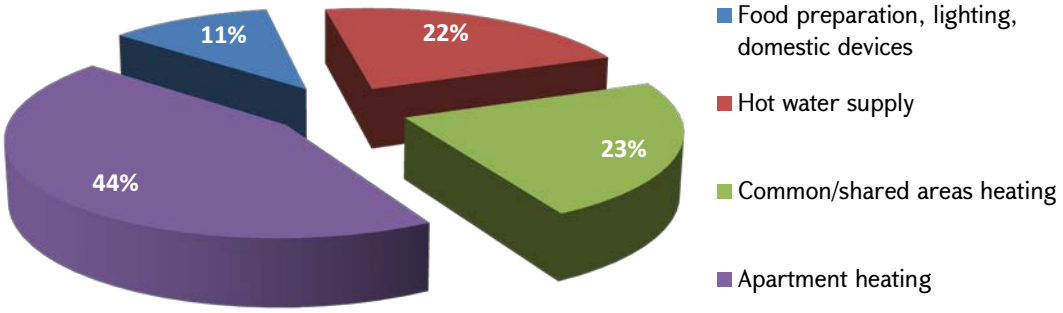

Figure 2. Energy carriers consumption by purpose

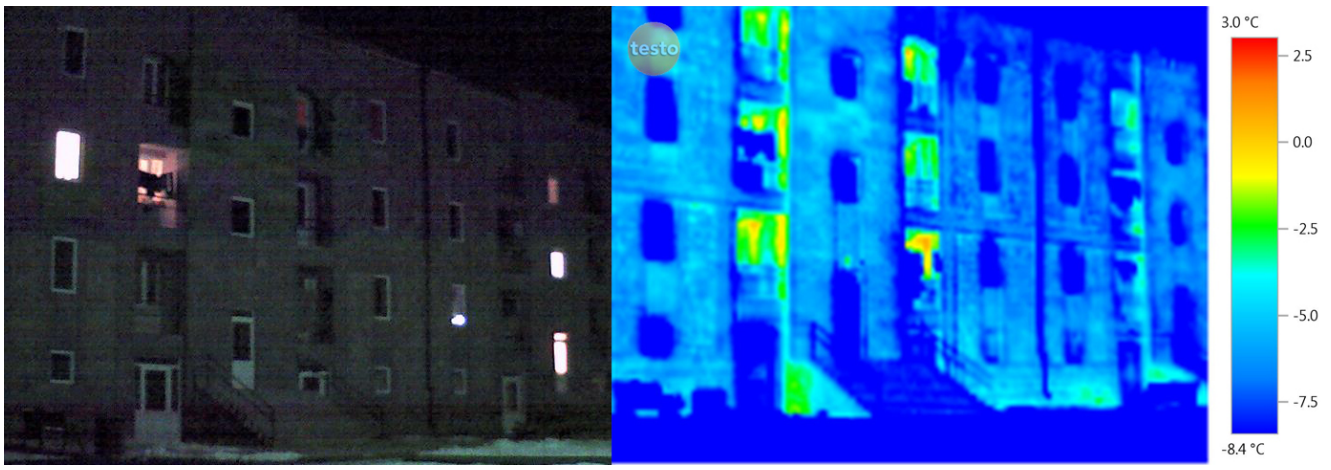

Figure 3. The northern side of building #151 on Mashtots street in Goris town, January 15, 2013 The shot produced with Testo 875-2 device.

Comfort level in the building's apartments reached 19.8°C (must be 20°C) with 16.1°C in the stairwells (must be 16°C). Comfort level as per the general average air temperature is estimated at 19.2°C (must be 19.3°C in accordance with the norm value).

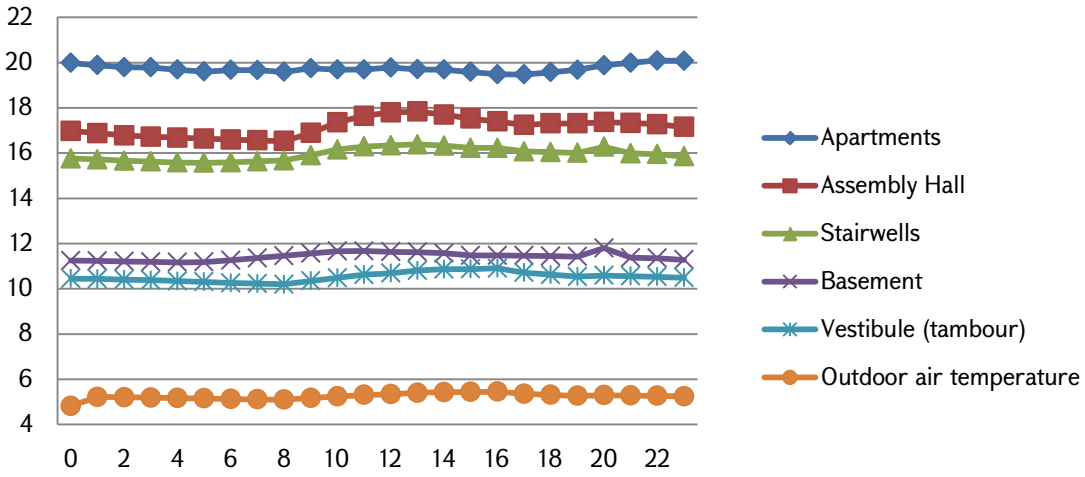

Figure 4. Average data on outdoor/ambient and the building's indoor air temperatures

The main factors of adverse impact on the building's energy performance are poor adjustment of apartment window frames and, due to improper operational regime of hot water supply system, a lower than the required temperature of hot water supplied to the apartments.

Design value of specific heat consumption in the building is 78 kWh/m^2 per year, while the monitoring findings show 99 kWh/m^2 per year value. With heat loss due to construction drawbacks and poor adjustment of the light penetrating structures estimated at 17 kWh/m^2 per year and accounted for, specific heat consumption in the building is about 82 kWh/m^2 per year.

Amount of heat energy required for the building's space heating is about 67 000 kWh/year or 7,800 nm^3/year given 92% boiler efficiency factor and 8,000 kcal/nm^3 thermal capacity of natural gas.

Compared to baseline design, CO_2 emission reduction in the upgraded building makes about 25 ton annually.