Savings in panel buildings

and how to address them

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Table of Contents:

1 Preface

Increased energy demands caused by neglected maintenance, as well as lenient requirements for thermal properties of building structures and equipment are a common issue regarding the current condition of the original panel buildings in the Czech Republic. The European directive EPBD introduces uniform and stricter requirements for energy consumption and consequently establishes conditions for reducing energy consumption and CO_2 emission. The implementation of these requirements leads to restoration and modernisation of panel buildings.
Panel building restoration involves not only financial issues and technical solutions, but also dealing with certain people, cooperating with companies, observing laws and decrees and, last but not least, considering residents in these buildings as your activities will significantly influence their lives for a certain period of time.

2 Introduction

The Czech Republic is facing the need for creating a systematic approach to solving sustainable construction projects and reduction of energy demands of buildings and the construction industry as a whole. The Czech Republic has established a few legislative and voluntary instruments.

Council Directive 89/106/EEC of 21 December 1988, on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products, was adopted prior to the Kyoto Protocol. The Directive requires that buildings and their HVAC equipment be designed and constructed in a manner ensuring low energy demands in view of the applicable local climatic conditions and user requirements.

Council Directive 93/76/EEC of 13 September 1993, on limiting carbon dioxide emission by improving energy end-use efficiency, stipulates that the member states are required to draft and implement programs for increasing energy efficiency in the construction industry.

Directive 91/2002/EC, on energy performance in buildings, was prepared for implementation in the Czech legislation in 2005. Act No. 177/2006 Coll., amending Act No. 406/2000 Coll., on energy management, was issued on 5 May 2006 based on the materials prepared under a PHARE project. The act is expected to reduce the energy consumption associated with construction and use of new buildings and reconstruction of existing buildings. Furthermore, this act should motivate investors and building owners to strive for the lowest possible operating energy consumption.

The energy performance of buildings is assessed according to the implementing decrees created as early as in 2006 (similarly to the national calculation tool). Buildings are classified according to the EPBD methodology under energy performance categories indicated in the “Building Energy Passports”.

Some of the tools that have not yet been approved in the Czech Republic include definition of the so-called sustainability measures – construction materials that should be used to prevent future excessive stress on the environment during their liquidation.

Although sustainable development and construction is currently widely discussed, load bearing structures in new buildings are still oversized during the design process and materials with a very low level of recyclability are used. Installation of cheap doors and windows and poor design of joints between construction elements and structures (occurrence of thermal bridges) are equally common.

The existing panel buildings are an example of this problem. These buildings represent the approach to housing development between the 1960’s and the 1980’s. Their liquidation is not viable in the Czech Republic firstly owing to the high cost of liquidating and recycling structures and building panels and secondly due to a lack of housing.

3 Description of current status

308 towns in the Czech Republic have housing estates containing more than 105 flats each built mostly using the panel technology. Approximately 1,165 thousand flats in total are situated in panel buildings, which accounts for more than 30% of the housing stock in the Czech Republic.
Panel housing estates were criticised extensively during the period after 1989. The outright rejection of this type of housing has now been replaced by a more realistic view of the future. Although panel housing estates will not disappear from our towns any time soon, a lot of technical, architectural and urban design improvements can be made. Residents in panel buildings encounter a range of specific problems on a daily basis. These include numerous faults in building structures or technological equipment, high energy demands, unsuitable interior microclimate, etc.

TABLE 1 Statistics of flats in panel buildings

Years 1959 – 1982				Years 1983 – 1998		
Year	Fully prefabricated			Year	Fully prefabricated	
	Number of flats	in %			Number of flats	in %
59 - 67	270,636	-		1983	30,601	97
1968	28,536	74.5		1984	34,617	98.2
1969	27,236	76.6		1985	40,450	98.3
1970	37,629	78.7		1986	37,252	98.3
1971	32,209	78.8		1987	27,028	99.1
1872	33,995	81.4		1988	30,107	98.9
1973	37,376	83.2		1989	33,659	98.8
1974	41,821	86		1990	20,997	95
1975	45,411	79.8		1991	20,979	87.2
1876	36,611	71.1		1992	13,386	85
1977	43,963	87.5		1993	6,763	59.8
1978	45,420	89.7		1994	6,021	74.4
1979	42,130	87.9		1995	1,936	20.3
1980	39,620	78.8		1996	949	23.2
1981	31,591	82.2		1997	1529	18.5
1982	28,908	82.8		1998	991	10.5

TABLE 2 Flats in panel buildings according by the year of completion

Completed buildings	Constructed of blocks	Fully prefabricated	Constructed of blocks (%)	Fully prefabricated (%)
1959 1967		270,636		24.2
1968 1970	12,572	934,1	15.2	8.3
1971 1975	21,210	190,812	25.7	17.0
1976 1980	27,284	207,744	33.1	18.5
1981 1985	11,264	166,167	13.7	14.8
1986 1990	1,021	139,043	1.2	12.4
1991 1995	6,183	49,085	7.5	4.4
1996 1998	2,966	3,469	3.6	0.3

4 History of panel buildings

The first panel building was built in the former Gottwaldov in 1957. The numbers of completed flats in panel buildings reached 30 thousand and more from the 1960's to 1990. The share of panel building development was around 80% and reached its peak – almost 100% share in the 1980's.
The share of completed flats began to decrease dramatically in the 1990's and dropped to mere 10% by 1998. Conventional technologies were once again predominant in construction and the number of completed flats started to fall significantly.
Considering the age of panel buildings is important in view of the required repairs and maintenance of the housing stock in panel buildings. The statistics show that approximately 31% of all flats in panel buildings were built in or before 1970 and are therefore older than 35 years.
The current condition of panel buildings reflects their age. Buildings constructed in or before 1980 require repairs, including those that address the energy performance of these structures. As these buildings were constructed under the old thermal standard, their heating requirements are higher than those in buildings designed under the revised standard – thermal insulation was previously designed with a lower thickness. The condition of the external cladding on these buildings, in particular with regard to joints and seams, presents yet another problem. Adequate connection between thermal insulation was usually problematic around joints between panels. Joints are filled with concrete and sealed from the outside. This increases the risk of leakage in joints in older buildings. Wall panels between windows present another issue. These were usually constructed as prefabricated parts with poorer thermal properties and insufficient sealing between panels and windows. Technical installations, elevators, etc. are also approaching the end of their service life.

The overall perception of panel buildings by the general public tends to be negative. The main reservations are as follows:

- Low quality of buildings and flats with regard to their architectural design and layout;
- Service life of buildings and particularly their external cladding being shorter than expected;
- Simultaneous deterioration of large groups of panel buildings resulting from completion of large housing estates at the same time;
- General preconception regarding prefabricated structures.

Numerous technical faults in panel buildings increase this distrust. The main causes of failures and faults in panel buildings are as follows:

- Insufficient knowledge at the time of their construction (underestimated impact of temperature, moisture, shrinkage, creeping and climatic effects);
- Failure to observe technological procedures during production of prefabricated parts;
- Failure to observe technological procedures during assembly;
- Defects in project documentation;
- Insufficient finance allocated for construction (continuous reduction of the cost per housing unit during the course of construction);
- Minimal variety of construction products (cheap and low-quality products prevailed);
- Insufficient focus on quality (on the part of investors and suppliers);
- Intensified aggressive effects of the external environment (acid rain, etc.).

Failures and faults in panel buildings:

1) Failures and faults jeopardising safety – these involve problems with the structural properties and stability of certain structures (anchoring of certain parts, balconies) and fire safety;
2) Failures and faults jeopardising hygiene and health protection – in particular the occurrence condensed water and mould (a phenomenon related for example to faults in the panel joint design);
3) Failures and faults impacting on energy savings and thermal protection caused by inadequate thermal parameters of external cladding, thermal bridges, insufficient insulation properties of the original typified windows and panels between windows;
4) Failures and faults deteriorating end-use properties – leakage in structures (roofs, windows, joints, service life of construction parts, etc.);
5) Failures and faults impacting on operating costs (insufficient insulation of installations on mechanical floors, expensive lighting of common areas, outdated types of elevators with high energy requirements, etc.).

The majority of faults are related to cladding, heat distribution and energy consumption in buildings.

The experience in restoration of panel buildings currently available is extensive. The first repairs of cladding were carried out at the beginning of the 1990's and mostly involved removal of defects such as mould.
Insulating materials with a thickness of 50 mm were used as additional insulation during the first few years. The current trends are based on the requirements defined in the recently amended thermal regulations. The market offers a significantly wider range of materials and products, such as windows with multi-chamber frames and micro-ventilation. Although complete reconstructions of roofs are less frequent, the number of this type of repairs can be expected to grow gradually as the original waterproofing layers deteriorate. Heating system replacement will also become increasingly common depending on the service life of specific heating systems and the age of buildings.
The average duration of the complete reconstruction cycle is approximately 30 years. Complete reconstruction refers to the implementation of the following measures:

1. Thermal insulation and reconstruction of building cladding;
2. Installation of measuring and regulating apparatuses;
3. Thermal insulation of pipelines for heating and hot water passing through unheated areas.

Re 1) Thermal insulation and reconstruction of building cladding means thermal insulation of vertical external structures (savings of up to 20%); the energy consumption can be reduced by up to 10% by insulating roofs and replacement of the original windows for windows with a low heat transmission can lead to savings of approximately 25%. Green roofs with a green area collect moisture and thus improve the insulating properties.
Re 2) Installation of measuring and regulating technologies in buildings in connection with the hydraulic balance of heating systems, measuring the consumption of cold and hot water and proportionate measurement of heat consumption for individual occupants helps to achieve savings of 5 – 15%.
Re 3) Thermal insulation of heating water pipelines and hot water pipes passing through unheated areas can help to reduce the heat loss from pipelines by up to one half.
The extent to which the expected savings are actually achieved during the subsequent operation of buildings is influenced by two factors. Firstly, it is conditional on the quality of implemented measures – this factor can be influenced during project preparation and implementation processes. Secondly, the final outcome depends on the behaviour of building users.

IMAGE 1 Jižní svahy housing estate in Zlín

5 Characteristics and standards of housing stock

Permanently sustainable buildings must be comfortable buildings ensuring thermal, visual and acoustic comfort.
Thermal comfort should be designed for year-round maintenance. The recommended temperature ranges are 18 – 21 ℃ durin g the winter period and up to 27 ℃ during the summer period. Short-ter m increases in temperature above 28 ℃ may be acceptable under cer tain conditions but their duration must be limited to a few hours.

5.1 Building

Energy performance of panel buildings is a frequently used term when assessing the quality of individual buildings. Individual panel buildings differ from each other depending on the time of their construction. Older panel buildings constructed in the 1970’s have far worse insulation than buildings constructed after the review of the typified prefabricated building design. This difference is obvious for example in the thickness of polystyrene layers. While insulation in sandwich cladding used prior to the review in 1980 had a thickness of 40 to 60mm, insulation used after the review was 80 to 100mm thick. However, these differences do not concern exclusively building cladding. Insulation of different thickness was also used in roofs – around 6cm in older buildings and 10 to 12cm in buildings constructed later. In any case this insulation is insufficient. This situation is best documented in details of standard requirements for thermal resistance according to the ČSN 73 0540 standard – see table 3.

TABLE 3 Development of standard requirements according to the ČSN standard for thermal resistance

Norma ČSN standard	Outer wall R (m2.K/W)	Flat roof R (m2 . K/W)
ČSN 73 0540 from 1964	0.5	-
ČSN 73 0540 from 1977 Effective from 1979	0.95 – 1.0 – 1.1	1.8 – 1.95 – 2.15*
ČSN 73 0540 – 2 from 1994	Required – 2.0 Recommended- - 2.9 Acceptable – 1.25	Required – 3.0 Recommended- - 4.35 Acceptable – 1.9**
ČSN 73 0540 – 2 from 2002 (converted from R to U)	Required – 2.63 Recommended- - 4.0	Required – 3.33 Recommended- - 5.0
	Heavy outer wall U (W / m2.K)	Flat roof U (W / m2.K)***
ČSN 73 0540 – 2 from 2002	Required – 0.38 Recommended- - 0.25	Required – 0.3 Recommended- - 0.2

Note: * depending on thermal zones -15 C
**for reconstructions
***for heavy structures

The energy performance of a typified panel building can be documented on an example according to a completed audit of a panel building type TO6B with 3 sections, 9 floors and 74 flats – 30 years old.

TABLE 4 Impact of thermal insulation on energy performance of typified panel buildings

Parameter	Without thermal insulation	With thermal insulation
Actual heat consumption for heating (GJ/year)	2,130	1,100
Calculated heat consumption for heating (GJ/year)	2,470	1,320
Total heat loss (kW) (according to ČSN 06 0210)	491	262
Calculated heat consumption for heating (GJ/year) (one flat)	33.4	17.8
Heat loss per one flat – average (kW) (according to ČSN 06 0210)	6.6	3.6

The table summarising the impact of thermal insulation in typified panel buildings shows the energy performance before and after implementing complete additional thermal insulation when the requirements of the amended energy legislation and the ČSN 73 0540-2 standard from 2002 in particular were observed.

The proposed measures included:

- Thermal insulation of the building cladding with a contact thermal insulation system based on polystyrene foam with a thickness of 10cm;
- Replacement of the existing double windows with plastic windows with the heat transfer coefficient U (formerly referred to as k) of 1.6W/(m2.K);
- Roof renovation with thermal insulation based on sprayed polyurethane with a thickness of 6cm;
- Warming the basement ceiling with additional thermal insulation of polystyrene foam with a thickness of 5cm.

The achieved heat savings were 1030 GJ/year, which is a saving of approximately 52%.

5.2 Heating

The average temperatures in panel buildings without supplied heat regulation are higher than those in family houses and individually heated flats by approximately 4^0C. An increase in the temperature in a flat of 1^0C raises the heat consumption by 6%. The final difference in costs shows an increase of 24%.

Hydraulic balance and regulation of heating systems is the first step towards significant cost savings. Heating system regulation eliminates the need to heat the relevant building according to the weakest link (the room that is the most difficult to heat). Long-term experience and practical applications show that savings of approximately 15% - 20% can be achieved in well regulated heating systems. These savings ensure fast return on investment in approximately 3 - 5 years. The cost of regulating heating in a building depends on the size of the relevant building – the larger the building is, the lower the average price per flat is.

Fair allocation of the cost of heating is yet another important step towards achieving significant savings. Perfectly balanced and regulated heating systems create suitable conditions for an accurate and reliable scheme for allocating heat consumption to individual flats. Various types of heating cost indicators allow indicating heat consumption on individual radiators. Savings

of approximately 20% – 30% are achieved in well regulated and measured systems.
The installation of regulating valves on radiators stems from the Act on Energy Management, 406/200 Coll., where Paragraph 7, Section 6 stipulates the obligation of building owners or associations of unit owners to equip radiators in the relevant building with apparatuses regulating the heat supply to end consumers.
Thermal insulation in areas where heating is not desired also requires significant attention. This issue is regulated by Section 6, which prescribes heat conductivity of materials used for insulating heat distribution systems.

5.3 Hot water

Drinking water is becoming more and more expensive and the process of heating drinking water to obtain the so-called hot water (HW) is increasingly costly. Heat consumption in the case of HW preparation through central heating accounts for 20% - 25% of the household heat consumption. The specific consumption of HW per person differs greatly and ranges between 40 and 140 l per person and day with the HW temperature of 45^0C – 60^0C. As central preparation of HW is associated with very high energy demands (long HW distribution pipelines, often with very poor insulation), the use of alternative sources, especially solar systems, is very interesting. Responsible behaviour of users is a very important factor in HW consumption. Measuring HW consumption in individual households is one of the available economic tools. When old electric water heaters (with energy consumption of approximately 2,870kWh per year and flat) in flats are replaced by new heaters (with energy consumption of 1,730 – 1,830kWh per year and flat), energy savings of up to 35% can be achieved.

5.4 Ventilation and air conditioning

Adequate air quality should be ensured in the building design similarly to thermal comfort. The required volume of fresh air is greater than the amount necessary for breathing.
Natural ventilation is the most economical option. All other types of ventilation are associated with the cost of investment in the relevant equipment and the applicable operating costs. These types of ventilation are recommended for buildings constructed under the low-energy standard (50kWh/m2) or as passive buildings (15kWh/m2). These buildings require the use of controlled ventilation, which can be integrated with heat recuperation. Ventilation and HW represent areas where continuous promotion of the correct behaviour is vital.

5.5 Other consuming apparatuses

More than 40,000 elevators in the Czech Republic are fitted in panel buildings. This accounts for approximately 50% of all existing elevators. Most of these lifts have been in operation for 20 – 30 years and fail to meet safety standards or the new requirements regarding energy consumption. Lifts with lower outputs and rpm control are recommended with regard to energy savings.
Lighting of common areas is another energy consuming system. Most of these lighting systems use incandescent bulbs and this type of lighting leads

to significant electricity consumption during long-term use. Potential savings depend mostly on the application of the following measures:

- Economical light sources;
- Installation of movement detectors in staircases and entrances to buildings;
- Installation of staircase automats for two floors.

6 Defects in design and implementation of energy-saving measures

Author: Ing. Jaroslav Šafránek, CSc.

Blocks of flats built using the panel technology have been subject to damaged building structures, reduced technical service life and jeopardised stability of certain structures and buildings.

Centrum stavebního inženýrství, a.s., was entrusted with solving the public task "Restoration of panel buildings – construction physics, power engineering and fire safety". The company in cooperation with other organisations (STÚ – K, a.s., STÚ – E, a.s., TZUS, a.s., PAVUS, a.s., and KERAMOPROJEKT, a.s.) created and issued a series of publications entitled "Comprehensive restoration of panel buildings – structural systems…". Separate publications were created for all types of implemented construction systems from G 40 implemented from 1950 to VU – ETA and Larsen-Nielsen systems implemented until 1990. The publications describe procedures diagnosing panel buildings prior to their restoration, determining technological procedures for reconstruction of damages structures and defining principles for reducing energy requirements associated with operation of buildings, and principles for improving fire safety, acoustic properties or safety of building operation.

6.1 Restoration of structural properties of panel buildings

Panel building restoration designs are based on completed detailed surveys of the condition of these buildings. Construction surveys focused on the following areas:

- Mechanical strength and stability;
- Fire safety;
- Health protection;
- Safety of use;
- Protection against noise;
- Heat conservation and energy savings.

The surveys carried out in buildings of all assessed construction systems found no system with structural defects suggesting imminent serious damage to or destruction of the building. The requirements for structural reinforcement of cladding structures or related internal load-bearing structures are based on the detected faults and failures:

1. Cladding
2. Loggias
3. Restoration of reinforced concrete loggia rails
4. Measures regarding attics and roofs

6.2 Restoration of thermal properties and energy engineering of buildings

The construction designs of individual buildings reflect the standards and regulations valid at the time of their implementation. The requirement for

reducing the heat consumption related to the operation of buildings is one of the most important criteria with regard to restoration. Construction measures carried out in order to achieve energy savings influence not only energy performance of buildings. For example additional thermal insulation significantly improves mechanical properties of buildings (reduced heat and humidity related volume dilatation) and prevents rainwater from penetrating the joints between panels, which is the most common defect in panel buildings.
Reductions in heat consumption for heating in panel buildings were addressed by the following measures under the program:

a) Application of additional thermal insulation of walls, roofs and ceilings under or above unheated areas;
b) Restoration, modification or replacement of windows and external doors with windows and doors with appropriate thermal properties;
c) Regulation of heat supply to individual rooms inside the buildings to ensure thermal comfort while making use of passive solar radiation.

The design of additional thermal insulation is based on the application of contact thermal insulation systems with effective thermally insulating materials such as polystyrene foam or mineral fibre slabs. The thickness of thermal insulation is determined in a manner ensuring optimal balance between the achieved energy savings and investment costs involved in restoration of buildings with regard to heat consumption for heating. The designed thickness of thermal insulation layers is limited firstly by the options for secure fastening of these layers to the underlying layers, which is especially important in the case of underlying layers of light concrete, and secondly by the so-called yield of thermal insulation layers in view of other heat losses for example through windows and doors by transmission and infiltration.
Appropriate design of energy saving measures for windows and doors is vital for achieving energy savings in panel buildings. Replacement of windows and external doors is increasingly the preferred option in view of the age of buildings and the technical condition of windows. Very tightly sealing windows reducing air exchange in flats below the hygienic minimum were often used.
In addition, regulation of heat supplied to individual rooms is an essential part of the proposed measures. Heating systems need to be designed in a manner allowing zoning, i.e. shutting off individual branches for example on sunny sides of buildings. Regulation systems need to be linked with an appropriate response at the heat source to ensure that shutting off local branches does not result in overheating other sections.

6.3 Restoration with regard to health protection in panel buildings

The main problems related to health protection in panel buildings involved the use of harmful materials such as in sewage systems of asbestos cement used in certain older constructions and the occurrence of mould in flats.
The publications contain detailed discussion of the causes of mould occurrence and options for mould elimination.

6.4 Energy saving potential in panel buildings

The potential for achieving energy savings with regard to heating in panel buildings is great. Achievable savings for individual types of structures were determined by assessing heat consumption in insulated panel buildings.

TABLE 5 Potential savings in individual types of panel buildings

Construction system	Reduction of energy consumption by:
G 40	65%
G 57	60%
T 08B	50%
VVU-ETA	30-40%
Larsen-Nielsen	30%

The main problems in restoration of panel buildings involve:

- Poor standard of energy audits;
- Failure to implement measures recommended in energy audits;
- Poor standard of implemented energy saving measures;
- Failure to harmonise regulation of heat supply to buildings with heat sources.

7 Use of renewable energy sources

Sustainable design and concepts of buildings is not limited to construction materials and structures. When designing new buildings and reconstructions of existing buildings, technical equipment of buildings should be taken into account to ensure reduced energy and material requirements, greater use of renewable energy sources and minimised use of air conditioning in residential and non-residential premises.
Cogeneration units, production of heat using solar energy, production of electricity using solar energy and heat pumps rank among renewable energy sources. Other types of renewable energy sources, such as boilers using biomass, biogas, etc., are not subject to this publication. These are used separately for heat supply in large housing estates.

7.1 Combined production of electricity and heat

For the purposes of this publication, combined production of electricity and heat refers to systems using gas motors and generating units for electricity production. When cooling gas motors, the heat produced by the motor is used to heat HW or water required for heating. This system is usually applied for larger groups of buildings. Electricity production is subject to the system economy. The produced heat is accumulated in reservoirs and distributed as required.

7.2 Solar technology

The term solar technology involves a wide spectrum of solar energy application for various purposes, most frequently as a source of heat or electricity. Solar technology can be generally divided into applications using photothermal conversion of solar energy (solar heat technology) and applications using photoelectric conversion (photovoltaic and photoelectric cells).

Solar systems for preparation of hot water (HW)

This trend was initiated mainly due to the high prices of heat in central heat supply systems. Wider use of solar systems for preparation of HW in combination with central heat supply is expected to develop in future. The use of combined solar systems raises two main issues – firstly how to achieve a sufficient annual solar share and secondly how to avoid problems related to stagnation due to unusable excess of energy during summer. Integration of solar collectors in the vertical cladding of buildings under the “optimal” angle instead of the conventional rooftop installation may be one of the solutions to this problem.

Heat reservoirs are the core of solar energy systems. If the accumulation capacity of a heat reservoir is not designed accurately (whether in view of heat requirements in the building or with regard to the applicable collector area), this fault has a significant impact on the final parameters of the relevant solar energy system (solar share, specific yield). The current trend with regard to heat reservoirs is to control the process of "charging" reservoirs in order to increase the usability of solar gains in heat consumption circuit and to reduce the built-in volume by using substances with a high accumulation density (substances with conversion of state of aggregation).

Water reservoirs (liquid solar energy systems) are the most common and the most frequently used heat reservoirs in solar technology. The second, less common type uses gravel (air solar energy systems). Both of the types mentioned above use sensible heat. The so-called stratification reservoirs used especially in large solar energy systems in combination with low-flow collectors are among the recent innovations in water reservoirs (pressurised, non-pressurised) available also on the local market.

7.2.1 Photovoltaic (PV) cells

The current technology offers two types of cells:

- First generation made of silicon plates – currently the most common
- Second generation made of polycrystalline, microcrystalline or amorphous silicon integrated in damp-proofing layers.

Both types of photovoltaic cells are connected to the electric grid **(on-grid)** and are used most frequently in areas with high density of electricity distribution networks. When the available solar radiation is sufficient, energy consuming apparatuses in the relevant building are operated with "solar" electricity and any excessive energy is supplied back to the public grid. Electricity is consumed from the public grid when the energy produced in the solar energy system is not sufficient. The system is fully automated owing to the microprocessor control of a grid inverter. Connecting these systems to the grid is subject to approval of the relevant energy supplier. The peak output of photovoltaic systems connected to the public grid ranges from kilowatts to megawatts.

IMAGE 2 System of photovoltaic panels made of monocrystalline silicon

This type of a system currently appears to be an interesting investment opportunity (subject to a subsidy being provided) as the entire production of a PV power plant is sold to the grid at the so-called purchase tariffs. The purchase price specified for the Czech Republic for 2008 as the minimum price with a guarantee of this amount for at least 15 years is CZK 13.46 per kWh. Possible application: roofs of family houses 1-10 kW_p, facades and roofs of administrative buildings 10 kW_p – hundreds of kW_p, noise barriers along highways, free-standing photovoltaic power plants, etc.

The main elements of on-grid PV systems are the following:

- Photovoltaic panels;
- Voltage transformer (inverter), which converts direct-current voltage to alternating-current voltage (230V/~50Hz);
- Wiring;
- Apparatus for measuring produced electricity (electrometer);
- Optional sun tracker, indicators, gauges.

Photovoltaic cells may be manufactured as panels allowing better use of sunlight owing to optimal positioning of panels towards the sun or installed directly on rooftops.

7.2.2 Second generation PV cells

EVALON-Solar is an integrated damp-proofing and photovoltaic system designed for flat roofs meeting the requirements of the BIPV Directive (Building Integrated Photovoltaics) on integration of photovoltaic system elements in building structures. EVALON-Solar functions simultaneously as a high-quality and reliable damp-proofing layer meeting the requirements according to ČSN 73 1901 and a powerful unit for generating electricity owing to the integrated photovoltaic cells. The EVALON-Solar system is based on strips of the EVALON damp-proofing film with a thickness of 2.8 mm with thin-layer flexible photovoltaic cells made of amorphous silicon integrated in the top layer of the damp-proofing film. The cells are connected in series as modules. Installation of the EVALON-Solar photovoltaic system does not require any fixed supporting or other load-bearing structures as in the case of conventional photovoltaic systems. Numerous passages through the damp-proofing layer as potential causes of leakage are thus avoided. Cells used in the EVALON-Solar system are flexible and can be installed without any problems even on uneven surfaces. The basic elements of on-grid PV systems are identical in photovoltaic panels and in cells integrated in damp-proofing layers.

IMAGE 3 Placement of panels on the roof of the Jena educational centre (8.4 kWp)

7.3 Heat pumps

The use of heat pumps offers a great potential for buildings built or reconstructed according to the low-energy standard. Water from a suitable source (water course, underground water source) or the surrounding air, as well as other sources, such as waste water or exhaust air from HVAC may be used as the source of heat. The heat generated from the sources listed above can be used especially for preparing HW and for additional heating. Heat pumps are not suitable for heating in large buildings. When the ambient temperature is low, the output of heat pumps needs to be maintained with an external heat source. Central heat supply or other sources, such as a boiler using gas or biomass can be used for these purposes.

8 Financing energy saving measures

The current harsh reality is that no owner, be it a housing association (hereinafter only as a HA) or owners acting jointly under an association of unit owners (hereinafter only as an AUO), cannot expect anyone else but themselves to take care of their property. By acknowledging this fact, an owner makes the first and perhaps the smallest but undoubtedly the most important step towards the resolution that any change is in their hands.

There are two options for financing energy saving programs – either saving gradually in the repairs fund, or borrowing the finance required for the investment and gradually repaying the loan through the subsequent “saving” in the repairs fund. The option of saving is a very slow one. First you save a certain amount and then make a certain individual investment. Saving finance sufficient for comprehensive reconstruction would require years of effort. The reasons for making use of a loan for this type of investment as many similar entities have done so far are explained in the following text.

8.1 Fears of loans for restoration of panel buildings are unnecessary

Ing. Ladislav Koucký – specialist in financing HA and AUO

Many owners decided to carry out comprehensive reconstructions of their buildings during the previous years and they would confirm even today that this change not only improved their living comfort, but also increased the value of their flats and brought significant savings in the cost of heating. By assessing hundreds of buildings as examples, we can calculate precisely that savings in the cost of heating ranging from 35% to 60% have been achieved through comprehensive thermal insulation in combination with replacement of windows and these savings were achieved at a stage when energy prices are virtually guaranteed to grow. These findings provide solid arguments even for those who have so far doubted the benefit of these types of investments.

8.1.1 Why invest now?

As mentioned above, the key is to find convincing arguments why this is the right time for making the investment. These reasons must be genuinely accepted especially by members of HA boards or members of AUO committees. Convincing the other members about the benefits while also informing about potential obstacles in financing the investment will be up to them. Specific reasons other owners who have made similar investments considered crucial can be summarised in the following points:

- Prices of construction materials and cost of labour (the annual increase in these costs in many cases above the inflation level has been confirmed);

- Achieving savings in the cost of heating (direct return on investment has a great impact on this factor as prices of heating media will never decrease and are more than likely to increase);
- Interest rates applicable to loans (event the current interest rates can be considered very advantageous);
- Further deterioration increases the cost of future investments;
- The investment significantly raises the value of the members' or owners' property.

8.1.2 What is the first step?

Firstly, it is necessary to obtain precise information on the cost of the potential investment. These details provide the necessary basis for all subsequent consideration. The cost of individual stages of the potential reconstruction needs to be established – how much window replacement, comprehensive thermal insulation, distribution system replacement or elevator restoration would cost. Once you have all these details, you will be faced with the first decision – whether you will complete individual stages gradually or carry out the entire reconstruction at once. If you summed up the total cost of gradual reconstruction completed over a few years and compared it to the original quote for comprehensive reconstruction, you would see that the gradual approach did not pay off from the financial point of view. However, whichever option you choose, you will be faced with the reality that your own resources saved in the repairs fund are vastly insufficient for making the planned investment.

This is the right moment for addressing a bank and requesting information on various credit options – these options should address different loan amounts (this will help you decide whether financing the entire investment at once is acceptable for you or whether this option is unfeasible for you and you will therefore need to make gradual investments) and different loan terms. Your bank will give you all necessary information and offer you a specific interest rate valid at the time of the offer. Taking this offer into account, compare the amount of your current monthly contributions to the repairs fund per m^2 of floor area against the amount of contribution that would be required in future to cover loan repayments. Your current contributions to the repairs fund may be sufficiently high and you may not need to increase contributions after taking out a loan as the current amount is adequate for covering loan repayments and interest. If this is not the case and contributions need to be increased if a loan is to be taken out, you have two options once again – if you prefer not to increase the contributions to the repair fund, you will have to opt for a partial investment. On the other hand, if you decide to raise the repair fund contributions, you will need to assess whether the required increase is financially viable for the residents of the building.

8.1.3 What should a loan proposal include?

Any subsequent decisions on taking out loans will be subject to obtaining basic information necessary not only for your decision making, but also for presenting arguments to other members or owners in order to convince them that a certain option is the right choice. Although the parameters of loans offered by various banks in the Czech Republic are currently very similar, there are still some differences. How do you choose the right bank that will understand your needs? It is quite simple – address banks well experienced in providing loans for repairs, reconstructions and modernisations of apartment buildings owned by HAs or AUOs specialising in loans for HAs and AUOs that have sufficient capital. Your request for an indicative offer should ideally specify credit options you wish to enquire about with regard to the amount of repayments, loan amount or loan maturity, in addition to all required initial details (legal form, number of flats, ownership structure, volume of planned investment, amount of own resources, etc.). What should a proper indicative offer contain?

a) Maximum loan maturity

Loan maturity of 10 to 15 years is fully sufficient in most cases because the longer the loan maturity is, the lower the monthly payments are but longer loan maturity also increases the total interest paid on the loan. Banks currently provide loans with maturity of up to 20 years.

b) Interest rate

Your bank should offer you a choice of three basic options of the interest rate structure – variable interest rate depending on PRIBOR (PRIBOR is the price of currency on the interbank market published by ČNB), fixed interest rate for the entire term of payment or interest rate fixed for a period shorter than the total term of maturity. Calculation of the interest payable for the entire loan maturity, i.e. how much the total interest on your loan will be, is essential information you should definitely request!

c) Fees associated with the loan

When providing loans, most banks charge fees for assessing loan applications, providing loans and fees for administering a credit account payable throughout the life of loan. Ask your bank to specify precisely what other fees they may charge - for example fees for reserved finance in the case of gradual drawing on your loan or fees for completing an expert opinion on the value of your property. ***Only the sum of all anticipated fees plus all payable interest will show exactly the total financial cost of a proposed loan! One final advice – decent banks only charge fees for assessing loan applications once the loan has been approved and you have signed a credit contract.***

d) Form of repayment

Loan repayments may be linear, i.e. constant monthly amount for principal repayment + payment of interest on the current outstanding amount or progressive interest payment, which means that the monthly amount for principal repayment is low at the beginning of the loan term and gradually increases – interest is the highest at the beginning of the loan term and gradually decreases. HAs and AUOs often request the so-called annuity payments, which means that all monthly payments throughout the loan term or throughout the fixed interest period are identical and include principal repayments and interest payments. This form of payment is very popular because payments determined in this manner are very easy to divide between individual cooperative society members or owners.

e) Required loan security

There are some cases where banks currently do not require any security but this usually applies exclusively to AUOs with the average debt per one flat lower than CZK 200 to 300 thousand. In most cases banks opt for one of the following methods of securing loans:

1) Mortgage
Mortgage applies to the entire real estate in the case of HAs or to individual flats in the case of AUOs. The right of lien belonging to the bank that provided credit is recorded in the Land Registry in the relevant title deed of the mortgaged property.

2) Declaration of guarantee
This declaration is issued by owners or members of a cooperative society as physical entities. A declaration of guarantee states that a particular physical entity (or a husband and wife) guarantee a loan provided to a HA or an AUO up to a specified maximum amount. The specific amount is always equal to the guarantor's aliquot share in the total volume of the loan.

3) Blank bill of exchange
A blank bill of exchange or a bill of exchange issued by a debtor does not contain any maturity date or amount. Although this type of bill of exchange is covered practically by all assets of the entity taking out a loan, any concerns regarding this type of security or the potential for abusing the bill of exchange are unnecessary. Although the debtor or its statutory representatives sign a blank bill of exchange when providing this type of security, the so-called declaration on a bill of exchange is signed at the same time by the guarantor and the bank. This declaration specifies precisely when, under what circumstances and in what manner the bank is entitled to complete and claim the provided bill of exchange. By signing the declaration, the debtor's statutory bodies confirm that the legal entity they represent guarantees the relevant loan through the bill of exchange – in other words their signatures as statutory bodies of the relevant legal entity mean that they do not guarantee the relevant bill of exchange as physical entities.

4) Bland bill of exchange endorsed by all owners or cooperative society members
All cooperative society members or owners who endorsed, i.e. co-signed the bill of exchange become guarantors as physical entities. However, this option cannot be considered practically identical to a combination of options 3 and 2, one major difference being the fact that physical entities endorsing a bill of exchange each guarantee the total sum stated on the bill of exchange, while the maximum amount guaranteed by a physical person in the case of a declaration of guarantee is always limited by a specific amount.

5) Guarantee provided by ČMZRB under the PANEL Program
In exceptional cases banks may be satisfied with a security in the form of a guarantee provided by ČMZRB. These cases are exceptional because this type of a security only covers the maximum of 80% of the loan amount provided – is other words the bank in these cases assumes 20% the credit risk and practically expects to recover 80% of

its loss only if the relevant loan is not paid off. However, obtaining this guarantee is conditional on the investment meeting the parameters required under the PANEL Program. This form of security is specific owing to the fact that you as the debtor do not guarantee the loan with any of your assets and ČMZRB does not require any security for providing the guarantee. On the other hand, obtaining this type of a guarantee from ČMZRB is subject to certain fees.

f) Option of claiming interest rate subsidies

If the relevant investment meets the requirements for inclusion in the PANEL Program, you can apply for a subsidy reducing interest rate on your loan from ČMZRB. Obtaining this subsidy has a significant impact on reducing the payable interest on your loan. This subsidy often covers a major part of the total payable interest and this naturally has a very positive impact on a dramatic reduction of the total cost associated with the relevant loan – see items b) and c). Your bank should be able to provide an estimate of the total subsidy for the entire term of payment in their indicative offer. However, you need to be aware of two important details. This subsidy can be claimed for no more than 15 years and the relevant subsidy is paid retroactively every six months provided that the loan providing bank confirms that the client paid its loan over the previous 6 months without any problems.

If you decide to compare offers of bank loans with credit options offered by building and loan associations, be sure to require the same extent of information from the relevant building and loan association. When the total costs associated with a loan, i.e. the sum of money you will need to pay for all fees and interest rates throughout the term of payment, are compared, bank loans are usually found to be the cheaper option. On the other hand, an offer from a building and loan association may be more interesting for you for example due to more acceptable requirements for securing the loan. Assessing the weight of individual positive and negative aspects of specific offers is up to you. When deciding on a suitable financing option, be sure to consider the administrative tasks involved in all contractual acts required for obtaining a loan, i.e. whether the HA board or members of the AUO committee can carry out most of these tasks without excessive administrative burden on the remaining members of the cooperative society or owners.

8.1.4 What statutory requirements apply to decisions on accepting a loan?

If you have decided about the extent of investment, know the total costs associated with the investment and are familiar with the parameters of a potential loan and the impact of loan repayment on the requirements for creating the repairs fund, you need to make practically the last but also the most important step – present your plan to the members and justify why you consider the relevant investment and its financing by a loan the optimal option for your HA or AUO. The form of approval of loan acceptance and the manner of securing the accepted loan must be approved by the supreme bodies of the relevant HA (the general meeting or assembly of delegates) or AUO (assembly of owners) according to the currently valid legal regulations. These

conditions are stipulated in the Commercial Code for HAs and in the Act on Flat Ownership for AUOs.
In the case of HAs, the acceptance of a loan and the manner of securing the loan with the relevant HA's assets (i.e. mortgaging the real estate or issuing a blank bill of exchange) must be first approved by a majority of all members of the cooperative society for the mortgaged building. Subsequently, the same approval must be obtained from the general meeting (or assembly of delegates) of the entire HA. Obtaining approval with any other form of security required by the bank in the same manner even if it does not concern assets of the relevant HA (for example in the case of a declaration of guarantee or a guarantee provided by ČMZRB) is recommended (although the law does not stipulate this requirement).
In the case of AUOs, the relevant investment should be first approved by at least 75% of all owners for the relevant building. The acceptance of a loan and the manner of securing the loan should then be approved by the assembly of owners in accordance with the applicable articles of association and if security in the form of declarations of guarantee or mortgaging flats is required, approval must be obtained from all owners participating in the loan who at the same time guarantee the loan with their assets.
Approving the acceptance of a loan and the manner of securing the loan in accordance with the applicable statutory requirements is essential!!! No decent bank will provide a loan without a due approval process.
Finally, if you succeed not only in persuading all members about the benefits of the relevant investment and drawing a loan to cover the cost of the investment, but also in satisfying all legal requirements for approving your plan, all you need to do is finalise your negotiations with your suppliers and bank and sign all appropriate contractual documentation. Suppliers will undoubtedly clarify their budgets and deadlines and the bank will request many documents from you to assess the standard of your financial management and the degree of risk associated with the provided loan.

8.2 Which documents will the bank require for their decision making?

Listing precisely all documents the bank will require before it decides to provide a loan is not possible as certain specific requirements may differ from case to case. However, no HA or AUO that keeps appropriate accounting records needs to worry about not being able to satisfy the bank's requirements for completing and presenting documentation. Generally, most banks will require submitting the following documents:

- Extract from the Commercial Register or the Register of Associations (no older than 3 months);
- Articles of the HA or the AUO;
- Accounting documents (balance sheet, profit and loss statement) for the previous 2 years;
- Income tax returns for the previous 2 years verified by the relevant tax office;
- Certificate of meeting the obligations of a MBD or AUO against the state budget issued by the relevant tax office; certificate of meeting the obligations of a HA or AUO against the Czech Social Security

Administration issued by the Czech Social Security Administration (no older than 2 months) – both of these documents may be substituted by a declaration of no debts in the case of smaller entities;

- Minutes showing a resolution of the general meeting of a HA (or the assembly of delegates) or the assembly of owners of an AUO, expressing their consent with the repair, reconstruction or modernisation of the building, loan amount to be drawn for these purposes, and the manner of securing the loan;
- Written document containing a list of housing association members – lessees in the relevant building (or owners in the case of an AUO) and their consent with accepting and securing the applicable loan confirmed with their signatures;
- Extract from the Land Registry for the repaired, reconstructed or modernised building (no older than 3 months);
- Valid building permit, a certificate of notifying the relevant construction authority or, if applicable, order of the relevant construction authority to carry out maintenance or necessary modifications to the building;
- Investment plan and calculation of investment costs;
- Copy of the relevant cadastral map;
- Details of a building contractor or a contract concluded between the relevant HA or AUO and a building contractor ("Contract for Work");
- Overview of overdue receivables of the relevant HA or AUO, building subject to a loan, volumes and numbers of debtors.

8.3 Submitting applications for assistance for repairs under the PANEL Program

Source: State Housing Development Fund
E-mail: info@panelovedomy.cz
As of the 2nd April 2008 (Wednesday), new applications for assistance for repairs, modernisations and reconstructions of panel apartment buildings under the PANEL Program can once again be submitted through offices of Českomoravská záruční a rozvojová banka, a.s.
The conditions for providing interest rate subsidies have remained unchanged for now and are regulated by Government Decree No. 299/2011 Coll., as amended. The only change compared to the previous years is the fact that interest rate subsidies will only be provided up to 2 pp in accordance with the Government Decree referred to above this year. This applies to all applications processed under this year's SFRB budget, i.e. including applications submitted in autumn last year that were not satisfied from the finance available under the budget for 2007. Applications for bank guarantees provided by ČMZRB, a.s. continue to be processed continuously and without any limitations.

9 Energy services

The so-called service with guaranteed savings is another form of financing repairs and reconstructions of buildings. Under this method an energy service provider (Energy Service Company - ESCO) offers comprehensive services aimed at reducing energy consumption and costs of energy consumption in a customer's building. In the case of EPC, the savings in operating costs associated with energy consumption (and, if applicable, operating a power engineering system) achieved during the term of the contract between the supplier and the customer are the main source of financing energy saving measures. The specific duration and wording of contracts depend on particular technical (extent of savings), financial (stability of the external environment and the relevant entity, status of certain financial and economic indicators – interest rate, rate of price increase, etc.) and legal conditions (existing contracts with energy suppliers, customer's legal status). The invested financial resources are provided by a third entity (supplier, financial institution).

A few contracts of this type have been concluded in the Czech Republic. All of the buildings involved were social facilities – nursing homes, schools and temporarily cooperative houses. The contracts concerning cooperative houses were drafted in a manner allowing installation of thermostatic valves and ratio heat distributors and implementation of their reading at no investment cost to the cooperative society. As experience from Austria shows, the EPC method is especially suitable for reconstructions of large systems (heating, ventilation, cooling, air conditioning, lighting, etc.) involving measures for improving regulation and energy management. These must result in 15 – 25% savings in the original energy consumption.

10 Information sources

EKIS – Energetické konzultační a informační středisko (Energy Consultation and Information Centre) – these are regional consultation centres providing advice to entities interested in energy savings in all aspects – energy sources, heating systems, building structures, renewable energy sources, financing energy saving projects, household appliances, etc. A total of 80 consultation centres offering their services free of charge have been established in all regions and districts.

Státní fond rozvoje bydlení (State Housing Development Fund)

The State Housing Development Fund established by Act No. 211/2000 Coll. of 21 June 2000 is one of the tools for implementing the state housing policy. The objective of the Fund is to generate, accumulate and distribute finance for supporting investment in housing and use this finance in accordance with the law for providing support in particular in the following three areas:

- Supporting construction of flats, especially rental flats;
- Supporting repairs of the housing stock, especially repairs of buildings built using the panel technology;
- Supporting construction of technical infrastructure in municipalities, i.e. investment in land suitable for future housing development.

Numerous consulting agencies specialise in preparing materials necessary for submitting applications for obtaining a state subsidy under the PANEL Program and arrange the completion of energy audits and building energy passports, preparation of applications and negotiation with banks for cooperative societies.

11 Conclusion

Reduction of energy requirements is a complex problem, which can be addressed gradually in stages. However, thorough preparation and implementation in a single stage is recommended in view of the investment costs involved and the subsequent gains from energy savings. Users of buildings can influence the quality of prepared reconstruction through their active participation.

The extent of energy savings achieved in particular buildings is also greatly influenced by the behaviour of lessees, which cannot be predicted in advance with great accuracy. Ventilation, HW management, number of household appliances and their selection and use are some of the issues in which users of individual housing units will need to be continuously educated through information campaigns.

12 Examples

13 The Housing Association in Orlová saves 61% of the cost of heat after ten years (1996 -2006)

Author: Ing. Jan Katauer

The Housing Association in Orlová (BDO) systematically implements structural and technical measures for reducing heat consumption in 3,300 flats. The first energy saving measure – **installation of thermostatic valves and hydraulic balance of heating systems** was implemented in all flats in 1995 /1996.

Thermal insulation was applied on the first 18 sections during 1996 – 1999 as a part of repairs of panel defects without drawing on a loan. The original windows were retained. All metal windows with single glazing in all buildings were gradually replaced with plastic windows with double glazing. The glazed area of windows in corridors was reduced and some of the basement windows were eliminated.

Glazing was installed on the loggias in the first OP 1.11 type building without thermal insulation of the external cladding in 1998. This resulted in a decrease in the annual heat consumption of 161 GJ (21.4%) and the specific heat consumption decreased to 0.31 GJ/m2/year. This outcome stimulated great interest in installation of glazing on loggias.

The BDO has used loans from the Panel program extensively for comprehensive repairs of buildings since 2001. Besides installing thermal insulation on the external cladding of buildings and replacing windows, the housing association also systematically installs thermal insulation on roofs and elevator machine rooms, replaces entrance doors in buildings, constructs new draught screens and installs thermal insulation on ceilings in entrances to buildings. Sanitary units in flats are reconstructed and HW circulation pipelines are insulated. Complete modernisation of elevators is carried out as a part of restoration of individual buildings in order to reduce the required energy output for the elevator drive. Lighting systems controlled by movement sensors without the necessity to light 4 to 8 floors at the same time are installed in corridors.

As at the end of 2007, a total of 135 sections, which account for 93.7% of the BDO's housing fund, were revitalised at a total cost of CZK 873 million.

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TABLE 6 **Development of heat consumption from 1996 to 2006**

Year	Annual consumption in GJ	Heat savings in GJ	Heat savings in %	Price in CZK/GJ at the building base	**Annual savings in CZK**
1996	141,314	-	-	178.59	**-**
1997	116,221	25,093,	17.80	218.17	**5,474,540**
2000	71,054	70,260	49.70	350.32	**24,591,000**
2003	72,086	70,228	49.70	309.67	**21,747,504**
2006	54,273	87,041	61.59	340.56	**29,642,682**
Total savings in CZK					**202,501,002**

TABLE 7 **Specific consumption and cost of heating for the previous 10 years**

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
***Price in CZK/GJ**	178.59	218.17	288.74	320.0	350.32	340.43	310.02	309.67	324.93	331.19	340.56
Consumption GJ/m2/year	0.68	0.56	0.48	0.42	0.345	0.405	0.362	0.350	0.310	0.303	0.264
Cost CZK/m2/year	**121.44**	**122.17**	**138.59**	**134.40.**	**120.86**	**137.87**	**112.22**	**108.38**	**100.73**	**100.35**	**89.90**

*****_Price including VAT at the building base_

13.1.1 Summary

In 2006, when the average specific heat consumption was 0.264/GJ/m^2/year, the worst building no. 783 (type G 57) recorded specific heat consumption of 0.5 GJ/ m^2/year and costs of 170.28 CZK/m^2/year. The best result was achieved in building no. 935 (type BP 70) with specific heat consumption of 0.15 GJ/ m^2/year and costs of 51.08 CZK/ m^2/year.
The cost of heat required for heating buildings in 2006 was CZK 18.5 million and the total cost of HW supply was CZK 19.8 million. Given the expected increase in prices of heat and cold water, this issue requires addressing as urgently as installation of thermal insulation on the buildings.

13.2 Financial savings and repayment of loans used for restoring panel buildings

The BDO invested a total of CZK 873 million in revitalisation of 3,300 flats, of which loans account for CZK 613 million. The BDO gradually transferred all financial savings for heat to the repairs fund, accumulating total savings of CZK 202 million over 10 years. The loans have proven beneficial as the average loan amount per 1m^2 of floor area gradually grew.

TABLE 8 **Table of financial cost of loan repayment**

Year	**CZK/ m^2**	**CZK/flat**	**%**
2001	1,863	136,111	100
2002	2,105	129,252	113
2003	2,486	157,481	133
2004	3,015	192,307	162
2005	3,300	212,572	177
2006	4,357	290,147	234

In view of the current interest rates charged by banks, the Panel program provides a unique opportunity to borrow finance for 15 years very cheaply. Given that the net interest rate charged by a bank is 0.5% (after deducting the 4% covered by a state subsidy), the interest payable on a loan of CZK 1 million is CZK 5 thousand and a state guarantee for 75 % of the loan amount is provided in addition.

The BDO is a conventional cooperative housing society without an association of owners and more than one half of the BDO members have a unique opportunity to borrow additional finance for repairing the interiors of their buildings. The loans for complete revitalisation amount to 4,500 CZK/m^2 of a flat's floor area plus own finance.

Given that the maximum loan amount is 4,500 CZK/m^2 with a term of payment of 15 years and providing 500 CZK/m^2 of own finance, up to CZK 300 thousand can be used for repairing a flat with an area of 60m^2. The annual repayment on a 15-year loan of 4,500 CZK/m^2 of floor area is 300 CZK/m^2/year. Interest and fees payable to banks for account keeping amount to 24CZK/m^2/year for this sum. Creation of funds for financing regular operation of the building is prescribed to the amount of 48 CZK/m^2/year. The total required annual creation of the repairs fund for the 15-year term of loan payment and operation of the building amounts to 372 CZK/ m^2/year, i.e. 31 CZK/ m^2/month. The required monthly creation of the repairs fund for a flat with an area of 60 m^2 is 1,860 CZK.

To ensure that this amount of the repairs fund creation is affordable, the BDO has been gradually transferring all savings from heat consumption to the repairs fund in the form of reductions of advance payments for heating since 1997.

The creation of the repairs fund has gradually increased by this finance. The total amount for 3,300 flats was more than CZK 71 million in 2006. The minimum amount of creation of the repairs fund for the BDO is determined by the board of the housing association and this amount was determined at 27 CZK/ m^2/month for 2007.

The actual savings in heat consumption in the repairs fund amount to 10.45 CZK/ m^2/month, which is 33.7 % of the total monthly amount of the repairs fund creation (31 CZK/ m^2/month). The actual net payment to the repairs fund that burdens lessees' budgets amounts to 19.50 CZK/ m^2/month.

The example of the Housing Association in Orlová shows that the Panel program can also be used for revitalising interior of buildings and ensuring modern living in panel buildings for the next 40 years without excessive burden on the finance of housing association members.

IMAGE 2 Solar panels for preparation of HW, reconstructed building, heat reservoir for solar panels

13.3 Use of a solar system for preheating hot water

The solar system comprises 45 collectors with an area of 115 m^2, a reservoir with a volume of 5.5m^3 for accumulating heat generated from solar energy and an exchanger with a volume of 2 m^3 for preparing HW. The hot water from the exchanger is heated in a panel exchanger in the building's transfer station using heat supplied by ČEZ-EDĚ when required.

TABLE 9 **Results of solar system operation from January to September 2007**

Month	Energy gain GJ	Volume of heated water m3	Circulating pump consumption kWh	Gain GJ/m3	Heat supply from OPSS GJ	Water heating from OPSS + solar GJ	Share of solar energy in HW in %
January	1.6	91	25	0.02	70	71.6	**2.2**
February	11	252	66.2	0.04	57	68	**16.2**
March	36.2	303	155.8	0.12	59	95.2	**38.0**
April	53.5	275	217.6	0.19	48	101	**52.7**
May	44.1	232	200.8	0.19	41	85.1	**51.8**
June	42	213	197.1	0.20	34	76	**55.3**
July	50.9	239	239.6	0.21	27	78	**65.3**
August	49.3	221	220	0.22	28	77	**63.8**
September	35.1	262	161.9	0.13	43	78	**44.9**
Total	**323**	**1878**	**1484**	**0.147**	**407**	**730**	**43.35**

TABLE 10 **Return on investment with the annual gain of 340 GJ.**

Price of 1 GJ of heat in CZK	HA's own cost CZK 2.1mil.	Total cost incl. subsidy CZK 3.1mil.	Annual saving in CZK
350	17.2 years	25.3 years	**122,600**
450	13.7 years	20.3 years	**153,000**
550	11.3 years	16.5 years	**187,000**
650	9.5 years	14.1 years	**221,000**

A solar system for preheating cold water intended for preparation of HW is currently the only technically and financially viable solution for panel buildings that can reduce the price of HW for end users. Its operation is simple and the service life is at least 25 years.

IMAGE 3 Reconstruction of interior equipment in flats

14 Regeneration of the Kamenný vrch panel housing estate in Brno - Nový Lískovec

Author: Radka Tichavská, Ing.,

The **“Project”** involved reconstruction of panel apartment buildings carried out in order to reduce the cost of energy and improve the overall comfort of living.

14.1 Description of buildings and measures

Energy-saving measures were implemented and evaluated in the following buildings:
• Kamínky 6, Oblá 2 in 2001
• Oblá 3 in 2002
• Oblá 14, Kamínky 25-35 (6 separate sections) in 2003

All of the buildings listed above are built in the T 06B construction system (slag and expanded clay concrete panels with a thickness of 300 mm). Their thermal properties after the reconstruction meet the requirements of the ČSN 73 0540-2 standard – THERMAL PROTECTION OF BUILDINGS, Section 2: Requirements. The buildings are connected to a transfer station and the transfer station is connected to the Kamenný vrch boiler plant.

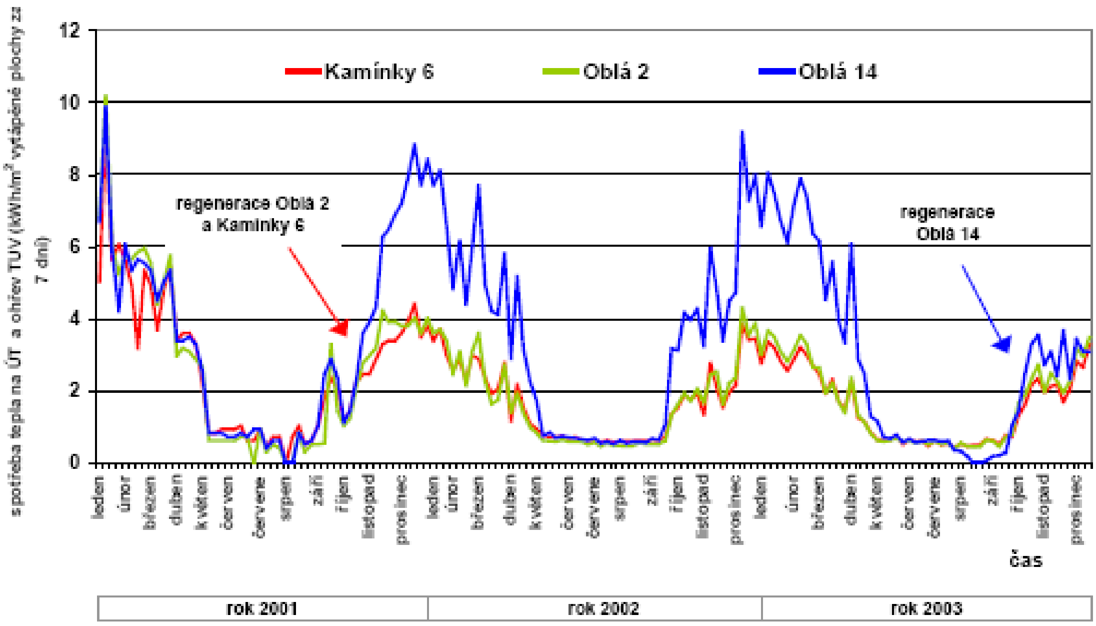
Overview of energy-saving measures implemented in these buildings:

- Thermal insulation of pipelines and heating installations;
- Organisational measures, energy management;
- Regulation of the heating system, thermoregulation valves;
- Replacement of windows, thermal insulation of external walls, thermal insulation of the floor above the basement, thermal insulation of roofs in accordance with the current standard;
- Controlled ventilation with a central unit and heat recuperation – only in Kamínky 6 and Oblá 2 buildings

14.1.1 Monitoring

Readings of heat consumption for heating and hot water preparation are taken every 7 days as a part of energy management, which was implemented as one of the energy-saving measures. Outside temperature is also monitored and the relevant 7-day average figures are calculated. This data is used to confirm the actual energy savings and to maintain energy consumption at the “correct” level (by detecting fluctuations in consumption from the E-t relation – see image no. 6.

IMAGE 4 Development of heat consumption in three buildings



14.2 Energy savings

14.2.1 Graphic representation

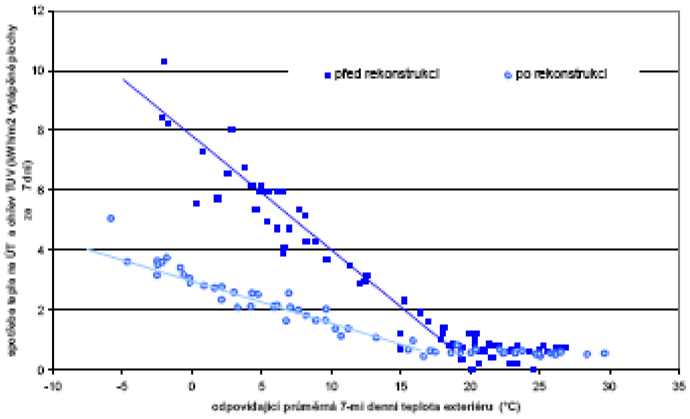
Image no. 5 shows the development of heat consumption for individual buildings over 3 years. Measurements were carried out every 7 days.

The following image no. 6 shows energy savings achieved in heating and preparation of hot water expressed through the relation between energy consumption and outside temperature (E-t curve). Each of the points represents a period of 7 days.

The steeper the curve is the higher energy consumption is. (There is inverse dependence between energy consumption and outside temperature during the heating season – energy consumed for heating, which increases with decreasing temperature, accounts for a major part of energy consumption; only hot water is heated when heating is not in operation and heat consumption is almost constant).

All points should be as close to the regression curve as possible. Any major deviations show a defect in the system or a faulty reading. (For example zero values mean a complete shutdown of the heat source.)

IMAGE 5 E-t curve – dependence of heat consumption of outside temperature



Heat consumption for central heating and preparation of hot domestic water (kWh/m^2 of heated areas for 7 days)
Prior to reconstruction
After reconstruction
Reflecting 7-day averages of outside temperature (°C)

14.2.2 Evaluation of obtained data

As energy consumption has been monitored for 3 years, the actual energy savings can be compared against the energy savings projected in the energy audit. The following table shows overview of heat consumption in reconstructed buildings according to individual stages.

TABLE 1) Overview of heat consumption in individual buildings

období rekonstrukce	objekt	spotřeba tepla na vytápění a ohřev teplé vody [GJ]				
		před zpracováním energetického auditu[1)]	předpoklad en. auditu po realizaci úsporných opatření [2)]	z reálně měřených hodnot [3)]		
				2001	2002	2003
podzim 2001	**KAMÍNKY 6**	1651	678	1184	853	807
podzim 2001	**OBLÁ 2**	1725	635	1194	858	858
podzim 2003	**OBLÁ 14**	1768	681	1550	1726	1438
podzim 2002	**OBLÁ 3**	900	297		678	406
podzim 2003	**KAMÍNKY 25-35**	4715	1279		4518	3887

1) počítá se jako průměrná spotřeba za tři ukončené roky před zpracováním energetického auditu
2) předpokládaná spotřeba tepla na vytápění a ohřev teplé vody po realizaci všech energeticky úsporných opatření doporučených energetickým auditem
3) vychází z odpočtů spotřeby tepla která je prováděna každých 7 dní

Time of reconstruction	Building	Heat consumption for heating and hot water preparation [GJ]				
		Prior to completing energy audit[1)]	Energy audit projection after energy-saving measures[2)]	From actually measured values[3)]		
Autumn 2001						

1) Calculated as the average consumption for three complete years prior to completing the energy audit
2) Projected heat consumption for heating and hot water preparation after implementation of all energy-saving measures as recommended in the energy audit
3) According to heat consumption readings carried out every 7 days

objekt	úspora předpokládaná auditem	úspora v roce 2002	úspora v roce 2003
KAMÍNKY 6	59 %	48 %	51 %
OBLÁ 2	63 %	50 %	50 %
OBLÁ 3	67%		54 %

Building
Saving projected in the audit
Saving in 2002
Saving in 2003

14.3 Conclusion

The actual savings achieved in all buildings are lower than the savings projected in the energy audit. This is mainly due to a failure to implement certain measures proposed in the energy audit, such as the installation of water-saving fittings (for example only 4 households of the 25 surveyed households in the Oblá 2 building have installed water-saving fittings).

Furthermore, residents themselves significantly influence heat consumption. This is mainly due to ventilating flats with open windows during the heating season as some people continue to leave their windows partly open for extended periods of time and thus increase energy consumption. Overheating the interior presents yet another problem (see chart no. 6). If the projections in the energy audit are based on interior temperature of 20℃, the estimated savings can never be achieved when almost 80 % of the households heat their flats to a higher temperature.

Regeneration of panel housing estates is a long-term process involving not only implementation of the project ideas but also a certain learning process for the residents as they learn how to live in the new environment.

15 Literature

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Number of Words:	12 497 (approx.)
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