MANAGEMENT OF HEAT ENERGY CONSUMPTION IN POLAND FOR THE PURPOSE OF BUILDINGS' HEATING AND PREPARATION OF USEABLE, HOT WATER.

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ABSTRACT: Polish climate causes that costs of heat energy used for heating and preparation of usable, hot water make significant part of financial resources in buildings maintenance. Focusing mainly on limitation of carbon dioxide emission and improvement of heat energy efficiency, worlds' tendencies of environment protection force changes as reduction of heat consumption in buildings. For administration it causes the need to fulfill severe norms of use of energy - the final one as well as the original, in relation to square meter of usable area of given building. These changes slowly increase society awareness in the field of necessity of heat energy consumption limitations. Yet there can be noticed too poor efficiency of those actions, caused by lack of proper economic support mechanisms. Public understanding of necessity, as well as advantages of introducing solutions that optimize use of heat energy sources is essential in process of rationalization costs of structures, improvement of building's heat energy profiles and reduction of greenhouse gases emission.

Key words: heat energy efficiency, thermo-modernization, property management

JEL code: Q43

Introduction: Climatic conditions and heat energy demand

Polish climate is a unique one and does not appear anywhere else in the world. It can be described as a temperate, warm and transient. This climate is placed between maritime and continental climates and because of that, polish climate has attributes of both mentioned above. Area of Poland can be divided in 5 main climatic zones (figure 1). The average annual air temperature depends on climatic zone and vary between 5,5 – 7,9 degrees centigrade [Polish Norm (Polska Norma) PN-EN 12831], the average sum of rainfalls – about 600 mm. It is worth to mention the temperature used for heat energy estimations like for example estimation of heat power according to Polish Norms, amounts depending on climatic zone from -16 in zone I to even -24 degrees centigrade in zone V which shows high dynamics of temperature changes.

Current climate in Poland was created as a result of mix of different air masses like: subtropical – maritime mass that comes from Azores High all year round, as well subtropical – continental mass that comes from North Africa, Asia Minor and southern-east Europe during summer and autumn. Mentioned above air masses have the biggest influence on polish weather in summer. In winter polar-maritime mass from north Atlantic that reaches Poland all year round, polar-continental mass from Eastern Europe and Asia predominant in winter and arctic mass from Arctic Sea determinate weather. Because all this, high changeability of weather types all year long and significant changes of weather in the following years are main features of polish climate [http://niezabijaj.eu].

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Fig. no. 1 - Territory division of Poland for climatic zones (according to PN-EN 12831)

Sources: Steszewski M., Wereszczyński P. Norma PN-EN 12831 Nowa norma obliczania projektowego obciążenia cieplnego, poradnik. Purmo, Warszawa 2008r

Climatic conditions present in Poland, its large dynamics of changes and low temperatures in winter cause that cost related to assurance of proper temperatures in usable structures, have huge influence on general operation costs. It is connected with delivery of accurate amount of heat energy carrier usually in the form of coal, gas, heating oil or wood, but as well with adjusting size of boilers. Good selection of heating installation power increases the efficiency of power production significantly as well as the efficiency of transferring, accumulation, regulation and exploitation.

Estimation of maximum amount of annual heat energy demand index

The heat loss in the building takes place mainly through exterior partitions, that is why ratio of external surface of the building to its cubature, called as well a shape factor A/V [m^2/m^3] is a very important parameter in estimation of essential heat energy consumption in given structure. This amount describes content of the building lump and enables estimation of maximum, assumed level of heat energy use in given building. A shape factor in small buildings and structures of complicated shapes, will amount higher than one and in big and simple shaped buildings this factor should be lower than 0,4 m^{-1}.

Figure 2 presents relation between quantity, level of complexity of building lump and estimated amount of shape factor. Based on analysis of relation between surface of the structure and its cubature, result in form of level of shape factor gives an architect in the stage of designing possibility to estimate (Laskowski L., 2008, s.139):

- potential saving of heat energy by minimization of total area of surrounding of heated rooms and comfort of residents.
- waste of heat energy and putting future owners to expense by designing fragmented lump of the building in the way that doesn't have any rational explanation.

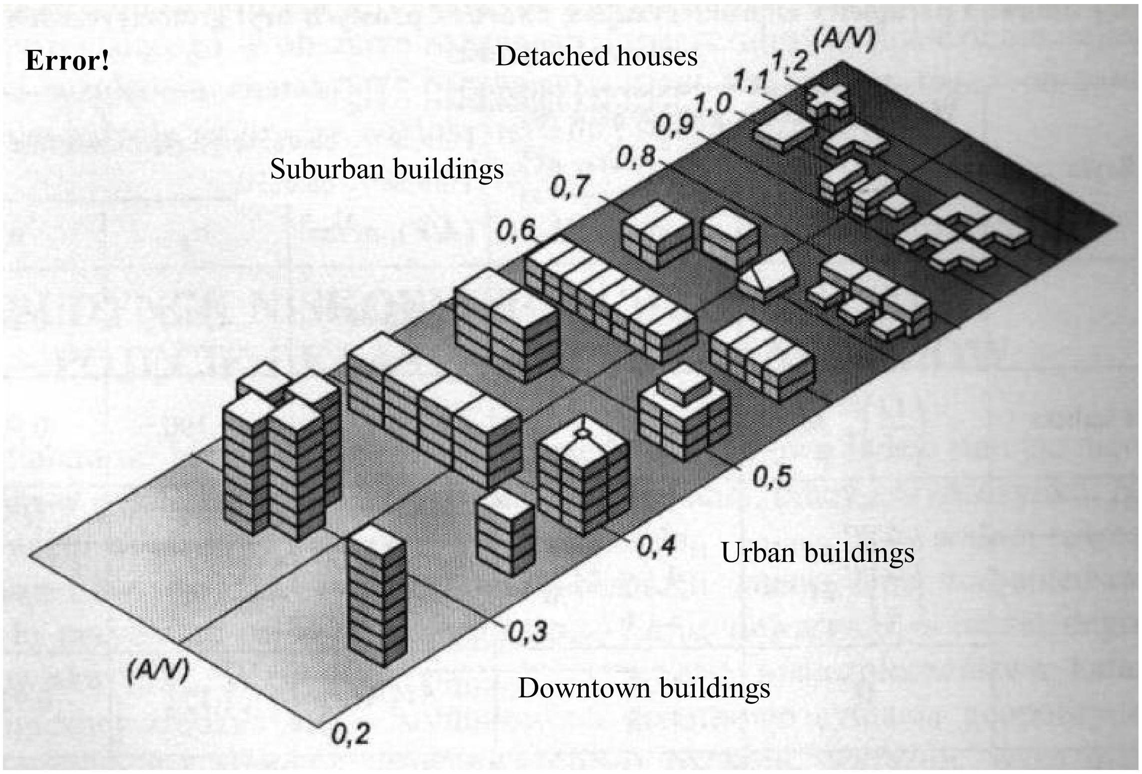

Fig. no. 2 - Diversity of shape factor value (A/V) that determinate buildings of contemporary construction industry.

Sources: Laskowski L., Ochrona cieplna i charakterystyka energetyczna budynku; Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2008 s.139

Poland wanting to fulfill directive 2002/91/EC of the European Parliament and of The Council of 16 December 2002 concerned heat energy quality of buildings [Dziennik Ustaw Nr 201, poz. 1238], brought into effect decree of Ministry of Infrastructure of 06 November 2008, which was an amendment of decree concerned technical conditions that buildings should fulfill and its location [Dziennik Ustaw Nr 201, poz. 1238]. This way level of heat energy use depending on shape factor was determined.

Maximum amount of annual computational index of demand for non-renewable, origin heat energy for heating and ventilation (EP [kWh/(m^2*year)]) was specified as follows:

- A/V ≤ 0,2; EP = 73 [kWh/(m^2*year)],
- 0,2 ≤ A/V ≥ 1,05; EP = 55 + 90 * (A/V) [kWh/(m^2*year)],
- A/V ≥ 1,05; EP = 149,5 [kWh/(m^2*year)],

where:

- A – sum of all areas of partitions in the building, which separate heated part of the building from outside air, soil and adjacent, not heated rooms, it is calculated based on exterior contour,
- V – cubature of the heated part of the building, lessen by arcades, balconies, galleries etc., it is calculated based on exterior contour.

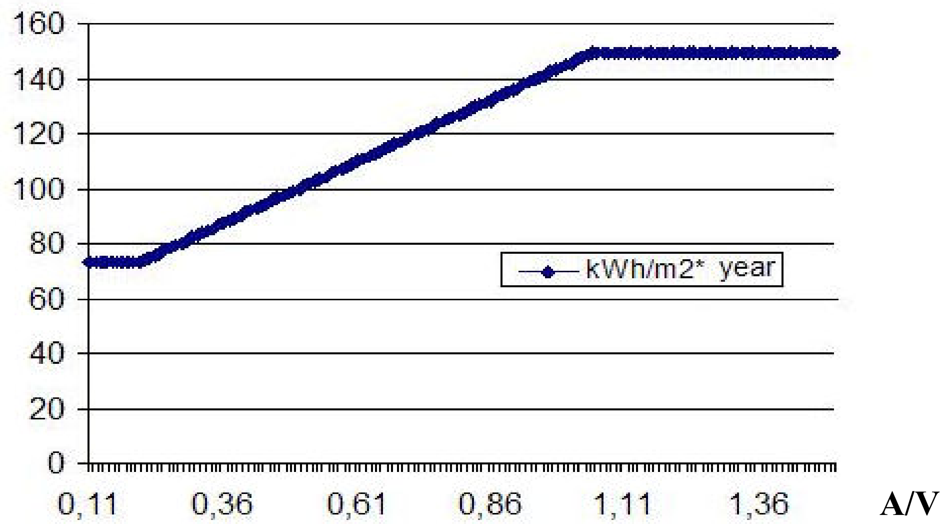

Fig. no. 3 - Maximum amounts of annual computational index of demand for non-renewable, origin heat energy for heating and ventilation – own estimation based on decree of Ministry of Infrastructure of 06 November 2008 [Dziennik Ustaw Nr 201, poz. 1238].

Determined this way maximum heat energy use corresponds with present standards of heat energy consumption and is an index of building's quality. Figure 3 is a graphical presentation of maximum amounts of annual computational index of demand for non-renewable, origin heat energy for heating and ventilation level. Applied method that makes size of building depending on border demand for heat energy, shows that smaller structures with more complicated shapes shouldn't use more then 149,5 kWh/m^2 per year. Big and less complicated buildings shouldn't exceed the amount of 73 kWh/m^2 per year. Conduct analysis prove that size of the structure exactly or to be more specific – bigger surface with regulated temperature in big buildings allows achieving required maximum values.

Methodology of demand for building's heat estimation.

The Infrastructure Ministry' decree concerning estimation methodology of heat energy profile of the structure and private accommodation buildings or part of the building which is separated, technically-utilitarian unit and way of pattern of heat energy profile certificate preparation of 06 November 2008 [Dziennik Ustaw Nr 201, poz. 1240] is base for issuing of structures' heat energy profile certificates. Included in Decree pattern of calculations is based mainly on buildings' heat energy balance and is similar to pattern shown in figure 4. In accordance with decree and EN ISO 13790:2004 norm, demand for utilitarian heat (Q_h) is estimated as a difference between total heat losses (Q_L) and usable profits (ηQ_g).

Figure 4 presents heat energy balance of the building. Included pattern shows borders of the zones. Zone 1 is heat energy balance of a heated part of the building, where delivered amount of heat (Q_h) together with usable profits (ηQ_g) covers demand for heat lost in partitions penetration process (Q_T) and heating, ventilating air (Q_V). Zone 2 defines amount of heat essential for usable, hot water preparation Q_{hw}. Zone 3 corresponds with border of heating system and shows losses of this system connected with its efficiency.

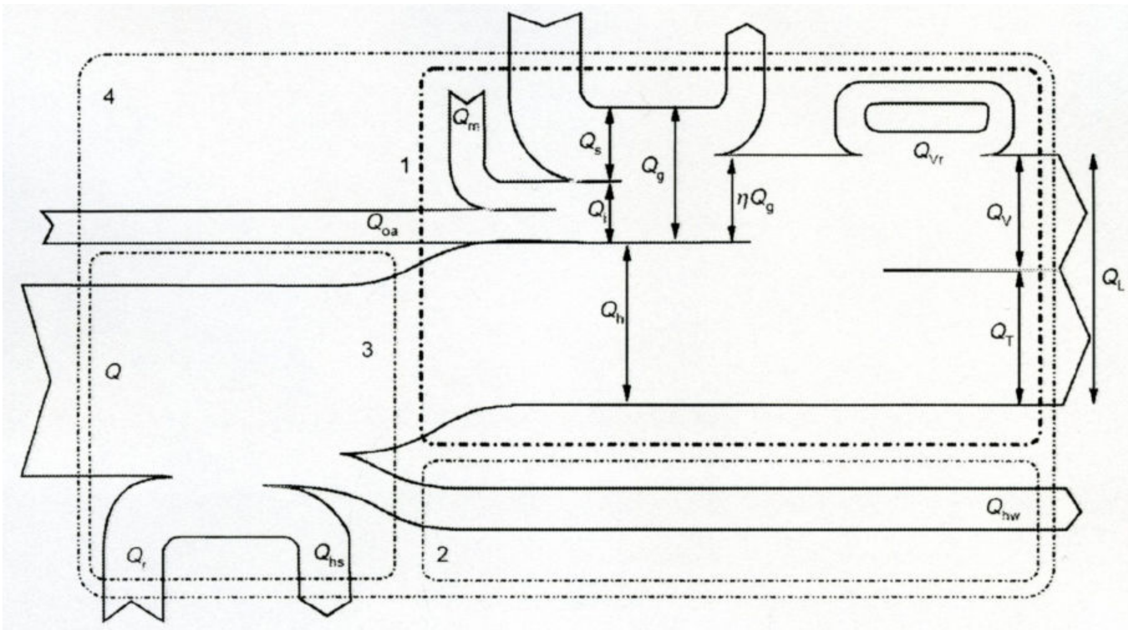

Fig. no. 4 - Heat energy balance of the building [EN ISO 13790:2004]

Where:

Q – heat energy used for heating
Q_{oa} – heat energy delivered from other devices
Q_r – recycled heat energy
$Q_{\eta s}$ – losses of heating system
Q_m – human heat
Q_s – profits from passive solar system
Q_i – internal profits
Q_g – profits in total
ηQ_g – usable profits
Q_h – use of heat
Q_V – heat losses for warming up ventilation air
Q_{Vr} – recycling of heat from ventilation air
Q_T – heat losses through penetration
Q_{hw} – heat needed for usable, hot water preparation
Q_L – heat losses in total
1 – border of heated zone
2 – border of usable, hot water preparation system
3 – border of heating system
4 – border of the building

The result of conducted heat energy calculations based on methodology included in Infrastructure Ministry' decree of 06 November 2008 allows evaluating buildings' heat energy efficiency, which included in heat energy certificate values can be used for costs needed for structures' exploitation in filed of heating and usable, hot water preparation estimation. Moreover, it can be base for forecasting modernizations' effects of heating systems as well as thermal cover of the building. The use of this kind of tool in economical analysis of venture profitability can be very valuable source of information for a building' manager.

Possible actions to reduce heat energy consumption of buildings and governmental support programs.

Until beginning of the 90' problem of building's thermo-isolation practically didn't exist. Access to cheap heat energy source in form of coal and lack of proper isolation materials in the past, caused that many people still today treat thermo-isolation as redundant invention of administration. Lack of motivation is caused mainly by no noticeable need for a change. Power of installed heating system is strong enough for now, so temperature in structures like block of flats is above the norm. So why should it be better isolated?

This opinion yet, starts to evolve towards resolutions that reduce exploitation costs of structures. Reason for that is significant increase of heat energy sources price in last few years and individual accounting of heating costs in detached houses for example based on heat meters.

Quality improvement of heat energy profile of buildings caused reduction of demand for heat energy sources and reduces carbon dioxide emission. Binding act of 21st November 2008 concerning support for thermo-modernization and renovations [Dziennik Ustaw Nr 223, poz. 1459] is a proper tool and at the same time governmental support for investment as reduction of demand for heat energy. Mentioned above act introduce mechanism of donation called "thermo-modernization bonus" in form of financial resources to cover partly planned actions.

Base for this bonus is heat energy audit. It is a study in which evaluation of shape of exiting building from its features that has influence on heat energy consumption point of view is included, besides that in this document is calculated demand for heat according to earlier presented method. Next step is to determinate what kind of changes and improvements should be done to reduce heat energy consumption and exploitation costs.

Further procedure of estimation defines how profitable this changes and improvements can be and how soon spent financial resources will pay back.

Using thermo-modernization bonus, following rationalizations that allows reduction of heat energy consumption and will lower exploitation costs can be done:

- Replacing window and door carpentry to improve parameters of its thermo-isolation and tightness
- Better isolation of external partitions of the building (walls, roofs, ceilings above non-heated basements, floors on soil)
- Elimination of present heat bridges
- Efficiency improvement of heating system by for example modernization of heat source and adjusting its value to present demands, isolation of transferring system of heat factor, use of automation of control, actions of restoring pattern of hydraulic pipes and heaters (special sluicing out the installation)
- Modernization or replacing usable, hot water delivery system and installation devices that reduce consumption of water
- Improvement of ventilation system
- Inserting devices that use heat energy from renewable sources like: solar collector, heat pipes etc.

Procedure of receiving governmental donation is a complicated process. Getting thermo-modernization bonus forces, except of drawing up heat energy audit, as well construction project of executing actions. It causes that only managers of multifamily houses are trying to get governmental support in that field. In case of detached houses, costs of investment preparations significantly exceed value of possible granted donation.

Conclusions

Estimated outcome of input of heat energy index that is a result of introduced obligation of heat energy certification of buildings, shows great potential for possibilities of changes in field of heat energy efficiency and reducing heat energy consumption of buildings. All that gives possibility in the future of reducing costs of heat energy used for heating and preparation of usable, hot water.

Concluded research shows that significant majority of existing buildings, despite from thermo-modernization procedures like: replacing window and door carpentry, better isolation of external walls, do not fulfill rigorous requirements included in Infrastructure Ministry' Decree of 06 November 2008 [Dziennik Ustaw Nr 201, poz. 1240]. More complicated actions like better isolation of highest storey (alternatively loft), walls of heated basement or floor on the soil and remake of ventilation system that allows recycling heat of air removed from rooms, give chance to achieve appointed level of maximum heat energy use.

Proper execution of every pointed in heat energy audit solutions can contribute to reducing costs of heat energy delivery to the building by even 60-80%. Modification of supporting thermo-modernization governmental programs in way that facilitate grating the thermo-modernization bonus in detached buildings, together with executing thermo-modernization processes of multiple family structures, will reduce significantly use of heat energy sources and at the same time will contribute to reduction of greenhouse gases emission.

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8. EN ISO 13790:2004, PN-EN 12831:2006.