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REASONABLE ENERGY MANAGEMENT IN AN INTELLIGENT BUILDING

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Summary. In accordance with EU Directives and the circumstances existing as a result of the economic crisis, the reasonable use of electric energy contained in various energy carriers in civil engineering is a common and multidirectional issue. Several opportunities in the scope of integrated control of the installations in order to achieve maximum possible energy savings are ensured by an intelligent building. Furthermore, the issue of energetic audit has been discussed.

Key words: Intelligent electric systems, energy, automatic engineering, intelligent building, energetic audit.

INTRODUCTION

Any energy – efficient solutions are mainly associated with the control of energy demand and its reduction. The reduction of energy transfer losses should also be considered. During the world crisis, the European Union must cope with new challenges associated with energy. The majority of EU countries are dependent on supplies of energetic raw materials from Russia.

In spite of this fact, almost 20% of energy is wasted owing to the lack of its effective use. The importance of electric energy grows continuously in current economy. The major part of main energetic raw materials is converted into electric energy. A significant part of energy is lost as a result of its ineffective use. The increased energetic effectiveness will contribute to the saving of fossil fuels as well as to the reduction of carbon dioxide and freons emissions. The task associated with increased energy savings belongs to energy manufacturers and to its recipients. The companies emphasizing the reasonable use of energy, may actually have higher chances of success and further existence on a difficult market. The countries with the so-called developing economies should pay particular attention to the promotion of any activities directed toward efficient use of electric energy. Undoubtfully, the scope of aforesaid activities encompasses the application of new energy – efficient technologies in newly erected objects including, among others, more efficient building installations. In accordance with EU research, about 40% of total energy consumption in European Union takes place in buildings. A significant part of total energy consumption (about 75%) is caused by the households.

The basic fields of electric energy application in modern households are:

- Lighting,
- Household appliances,

- Data communication equipment,
- Electric heating and air – conditioning equipment,
- Lighting.

In comparison with the developed countries, the households in Poland are characterized by lower saturation with electric equipment. Assuming that the idea of the so-called sustainable development promoted in UE legislation will be continued in future and implemented also in Poland, further increase of electric energy consumption can be expected. Therefore the efforts required for rationalization and modernization should be initiated in this sector.

The best effects can be achieved as a result of modernization of the following elements of household electric system and the appliances being supplied from the aforesaid systems. The so-called energetic class is important in case of household appliances. Each manufacturer shall mark its product using the so-called energetic label (Fig. 1) illustrating the energetic class of an appliance.

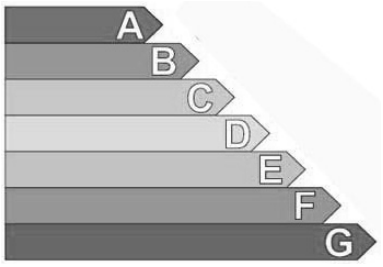

Fig. 1. Subdivision into energetic classes [4]

For instance, in case of refrigerators, nine (9) classes are used at the moment, beginning from the highest one: A++, A+, A, B, C, D, E, F; the final class "G" being characterized by the highest energy consumption. The symbols indicate the energy consumption levels during work. The lowest energy consumption is possible in case of appliances classified in the class A. Only the appliances meeting the established requirements in the scope of energetic effectiveness are approved for sale.

ENERGETIC AUDIT

An energy – efficient building is defined as the building characterized by design and technical solutions ensuring its use at low energy consumption, including the assurance of comfortable hygienic and sanitary conditions.

The energetic quality of the building is evaluated on the basis of the value of average annual energy consumption in a building; the said energy is used for the heating of 1 m^2 of the floorage. This value is calculated for the building being designed on the basis of the data originating from the design and on the basis of physically measured data in case of an already existing building.

Pursuant to the Act of 19th September 2007 on the amendment of Building Code (Journal of Laws No 191 of 18th October 2007 Item 1373), a system of energetic certificates for buildings with various functions and purposes, their separated parts and residential dwellings as well as the inspection system for heat sources (boilers) and air – conditioning equipment is introduced in Poland. The preparation of an energetic characteristics certificate is mandatory in case of:

- A new building being handed over for commercial operation,
- An existing building in case of its sale or rent to a new Tenant.

The energetic characteristics certificate is issued by a duly authorized expert as the document determining the value of demanded energy which is required in order to meet the needs associated with the use of a building or dwelling i.e. the value of demanded energy to meet the needs in the scope of heating, domestic hot water, ventilation and air – conditioning. The value of demanded energy is evaluated in this certificate on the basis of the destination of the building as well as its standard and installations i.e. on the basis of its constant objective features; not on the basis of energy consumption because the latter may vary depending on the method of use and the habits of users. The certificate contains:

- The basic data of building and value of demanded energy to meet the needs in the scope of heating, domestic hot water, ventilation and air – conditioning. In case of non-residential buildings also the energy to meet the needs in the scope of lighting and comparative indices.
- The guidelines and indications concerning potential improvements in order to reduce energy consumption.

The completion of university education and possession of at least a master degree makes it possible to obtain the licence authorizing to the issuance of energetic certificates, in any of the three following tracks:

- Possession of designing license in the scope of civil engineering.
- Completion of post – graduated studies (1 year).
- Completion of training and passing a state examination before the competent minister in the scope of civil engineering.

Pursuant to the act, the authorizations required to issue the energetic characteristics certificates are granted to those who:

- Are wholly capable to act in law.
- Completed at least university education (master degree) pursuant to the regulations on university education system.
- Have not been sentenced for offences against property, offences against documents, offences against company assets, money forging, for forging securities, official marks or fiscal offences.
- Possess the designing license in the scope of civil engineering in the specialization associated with architecture, structural construction or with installation and passed a state examination before the competent minister in the scope of civil engineering.

The period of certificate validity is 10 years. A new certificate should be issued when its date of validity is expired or if its energetic characteristics has changed as a result of the reconstruction or overhaul [3, 4, 6].

ENERGY – EFFICIENT BEHAVIOURS

The promotion of energy efficient behaviours is carried out in order to supplement the actions initiated in connection with the energetic audits in order to meet the requirements set to the contemporary buildings.

The whole installation is the property of the user are is built at the expense and efforts of the user. The latter is responsible for the condition of the electric system. The most important problem to be resolved in the designing phase is a high safety standard to be ensured for the users and low operation costs to be granted for the owner. The investors are supported by the intelligent construction solutions bringing measurable benefits to the users and owners of the buildings.

There are several standards of „an intelligent building”. Their operation principle is similar – the installations are subdivided into two kinds of buses i.e. into power supply and data bus. The

first part usually consists of 1ph or 3ph electric circuits and the second part operates as a data bus transferring the commands and feedback signals. Any element of the system has parallel connection to the power supply bus and to data bus. Individual elements of the installation (e.g. bulb, switch) are provided with their unique addresses and are visible for all the remaining elements.

In theory, all of them can be used as the controls for the remaining elements. It depends on the corresponding address being indicated. Therefore, any configuration of the building devices can be created without a necessity to modify any cable routes, but every room must be provided with power supply bus and data bus.

However there are still many older types of devices in the buildings. Their energy consumption is high, particularly in case of washing machines and refrigerators having long service life in most cases. Undobtfully, their gradual replacement by the new versions will contribute to the improvement.

A reasonable use of electric energy is also possible as a result of introduction of more efficient light sources, replacement of conventional bulbs by energy – efficient versions. However, the specific features of the rooms should be considered, because such light sources are not suitable for every type of rooms. They should not be installed in the rooms to be provided with lighting temporarily e.g. toilets, bathrooms or staircases.

The surrender of the use of „standby" function in the devices is another "energy – efficient" behaviour.

The maximum control systems installed in public utility objects, i.e. shopping centres, hotels etc. in order to prevent the exceedance of the peak power and to control the power consumption in accordance with the priorities setting performed by the user to switch off those energy receivers which are unnecessary at the moment. The intelligent construction solutions bringing measurable benefits to their users [3, 4] plays an important role in energy savings increase in recent years.

OPPORTUNITIES ASSOCIATED WITH THE BUILDING MANAGEMENT SYSTEMS IN THE SCOPE OF ENERGY SAVING

Thanks to the use of intelligent building management systems, potential energy savings are possible. KNX/EIB (European Installation Bus) intelligent systems occupy an important position among the building management systems. The scope of their operation encompasses automatic control for technical functions of a building, building safety functions and information flow. The basic idea of the system is to ensure a possibility of energy saving, convenience and development of individual functions of the installation and their modification. The bus installation as a common communication medium between various types of installations, is conductive to this solution. This bus has been installed as the pair cable 2x2x0.8 mm^2.

KNX/EIB system enables the control functions in the scope of lighting, heating and security systems [2].

LIGHTING CONTROL

An achievement of potential reduction of electric energy consumption is possible by means of bus devices which are specially designed as the control devices for lighting, heating and air conditioning installations. Particularly important is the integration of aforesaid installations i.e. for the exchange of information and their control signals to be mutually used.

Lighting is one of the most important elements in every apartment. The lighting scenes can be created by means of an intelligent electric system. The lighting scene makes it possible to control several lamps (with different power supply) simultaneously.

There are three basic types of lighting control: switching on lamps by means of actuators; dimming of selected lamps by means of universal dimmers and lamps' dimming by means of actuating – dimming actuators.

For instance, the lighting control is possible as the function of time and daylight illumination. The switch on/ off time settings in connection with photo – electric switches and with the system maintaining constant illumination make it possible to achieve a reduction of energy consumption by 30% up to 50%. The service life of light sources is also prolonged. The occupancy detectors (Fig. 2) are also used for lighting control to ensure lighting of the rooms only in case of their occupancy.

Fig. 2. Occupancy sensor [1]

An evaluation and possibility to switch off the lighting as a result of movement detected or not in the room is the basic benefit resulting from its use. Contrary to the conventional movement detectors, which are activated under the value of illumination considered as twilight, the illumination is measured and evaluated continuously and the lighting is switched on or off thereafter by the detector incorporated in an intelligent installation. Furthermore, a central switching system can be designed for lighting in the corridors and staircases.

The roller blinds control system can be integrated with the lighting system of the building in order to deliver information about sunrises and sunsets to the system as well as to enable their lifting or lowering.

HEATING CONTROL

Up to 70% of energy consumption in the building is associated with heating and hot domestic water. One of the most difficult problems energy sector is to ensure human thermal comfort in the rooms with diversified functions in the presence of occupants. Human thermal comfort is defined as the set of optimal physico – chemical indoor air parameters interacting with each other and directly influencing human health and comfort.

Human thermal comfort is determined on the basis of the following parameters: air temperature and its uniform distribution within the space of the room, relative humidity, the velocity of the air streams' movement and their temperature, temperature of the surfaces of the divisions enclosing the room, air quality determined in respect of its chemical composition (among others, content of nitrogen, oxygen, carbon dioxide); content of physical, chemical and bacteriological contaminants.

In order to enable the selection of an indoor heating device, knowledge on the thermal properties of a building, function of the room and its insolation is required [2]. Thermostats are used for indoor temperature control. In an intelligent building the temperature is continuously measured

and adapted in accordance with the requirements of users. The local temperature adjustment and its diversification within an apartment is possible by means of integrated control. An example of the indoor temperature subdivided into zones is represented in Fig. 3. The individual settings of temperature in individual rooms increases their comfort and positively contributes to the health of inhabitants. They are comfortable in the rooms with comfort parameters selected in a manner corresponding to their activities and clothes. The supreme principle in the building installations control is to supply energy only to the locations where it is required at a given moment.

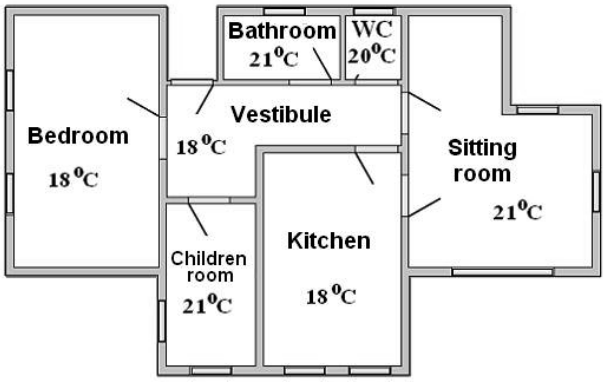

Fig. 3. Temperature zones in an apartment

CONCLUSION

On the basis of the preceding considerations, the reader can found that reasonable energy management is extremely important in the contemporary world. This task is promoted or even enforced by several factors: application of legislation promoting energy – efficient behaviours, legal regulations enforcing energy inspection of the used objects (energetic audit), application of energy – efficient systems of intelligent electric installations adding to the energy – efficient use of the buildings and simultaneously ensuring their high comfort. Furthermore, they make it possible to protect the natural environment constituting an undisputable value, our heritage and contribution into the development of future generations.

REFERENCES

Literature supplied by the Company ABB Polska, 2009.

Mikulik J: Europejska Magistrala Instalacyjna. Rozproszony system sterowania bezpieczeństwem i komfortem. COSIW, Warszawa 2008. (in polish).

Robakiewicz M. Materiały edukacyjne Fundacji Poszanowania Energii, Warszawa 2007. (in polish).

Serwis internetowy: http://oszczedzaj.epbd.pl, 2009. (in polish).

Strojny J.: Podręcznik INPE dla elektryków. Instalacje elektryczne. Wiadomości ogólne. COSIW Warszawa, 2004. (in polish).

Ustawa z dnia 19 września 2007 r o zmianie ustawy Prawo Budowlane (Dziennik Ustaw nr. 191 z dnia 18 października 2007 r. poz. 1373). [Act of 19th September 2007 on the amendment of Building Code (Journal of Laws No 191 of 18th October 2007 Item 1373)] (in Polish).

RACJONALNE GOSPODAROWANIE ENERGIĄ ELEKTRYCZNĄ W INTELIGENTNYM BUDYNKU

Streszczenie. Zgodnie z wytycznymi Unii Europejskiej oraz okolicznościami powstalymi na skutek kryzysu ekonomicznego, oszczędne zużycie energii elektrycznej w różnorodnych nośnikach budownictwa lądowego jest powszechnie i pod wieloma kątami analizowane. Pewne możliwości w zakresie zintegrowanej kontroli instalacji w celu osiagnięcia możliwie największej oszczędności energii występują w budynkach inteligentnych. Ponadto omówiono zagadnienie energetycznego audytu.

Słowa kluczowe: Inteligentne systemy energetyczne, energia, inżynieria automatyczna, intelligentny budynek, audyt energetyczny.