Journal of International Scientific Publications:
Materials, Methods & Technologies, Volume 7, Part 2
ISSN 1313-2539, Published at: http://www.scientific-publications.net

INFORMATION TECHNOLOGY TO DETERMINE THE ECONOMIC EFFECT OF AUTOMATIC LIGHTING

Nanko H. Bozukov
University of Food Technologies , blvd. "Maritza" 26, 4002 Plovdiv, Bulgaria

Abstract

The report describes the information technology for calculating the savings from the economic effect of the use of energy - efficient automatic lighting devices. Information technology is a good, convenient and reliable means of control and objective analysis. The algorithm is described by means of a flowchart. The program was developed using the programming language of the system for scientific and engineering calculations MatLab.

Key words: *energy - efficient lighting*

1. INTRODUCTION

The economic effect of the use of energy-efficient lighting devices with electronic ballast and automatic control is achieved by:

- improved emission of light by means of electric current of high frequency, and hence less power, while maintaining the intensity of the light;

- removal of the stroboscopic effect typical of fluorescent lamps;

- removal of the noise of electromagnetic ballasts;

- **preserving** the required level of illumination and automatically dimming the intensity of natural light.

2. GUIDELINES FOR ENERGY SAVINGS

The data availability and the ability of recovery are essential for precise and accurate assessment of energy savings in methodologies for energy efficiency. It is important that most accurate information and a set of necessary data are provided before any assessment. It should be borne in mind that with the evaluation of energy service or the measurement of energy efficiency it is usually not possible to rely on specific measurements.

It is necessary to distinguish between methods for measuring energy savings and methods estimating energy savings, the latter being more common and associated with much lower costs.

Energy audit is to determine the level of energy consumption in order to identify opportunities to reduce it and recommend measures to improve energy efficiency [7]. Methods have been developed that aim to demonstrate the implementation of individual measures or groups of measures to improve energy efficiency in various sectors of economic and social life [6].

Energy savings in industry are determined by measuring and/or estimating consumption before and after the implementation of the energy efficiency measure. The amount of the saved energy is equal to

the difference between the energy used before the introduction of the measure or program to improve energy efficiency and the use of energy, measured after administration.

The developed methods include the following directions [4, 5]:

- The replacement of equipment with such that is energy-efficient. In this respect, the baseline is the specific energy consumption of the existing equipment before the replacement, if there is evidence of it. When there is no evidence, that consumption as a baseline can be used for data average specific energy consumption of similar equipment available.

- Updating the equipment or the building. The baseline in this direction is the specific energy consumption before the modernization of the equipment or the building. If there are no specific data on the consumption of the equipment, the average consumption of such equipment available can be used as data. In the absence of specific energy consumption of the building prior to the implementation of energy saving measures, the baseline can be used for specific consumption of buildings built according to the design standards for the year of construction of the building.

- Acquisition of energy-efficient equipment or building. In this direction the baseline is the specific energy consumption of the older equipment before the replacement. In the absence of baseline data, the average specific energy consumption of the new equipment sold in the country in the base year, or the rules for the energy performance of buildings existing in the base year are considered.

3. DETERMINING FUEL ECONOMY WITH THE USE OF AUTOMATIC ENERGY-SAVING LIGHTING APPLIANCES

- Determination of fuel consumption when using incandescent or fluorescent lamps with electromagnetic ballast [2].

- Determination of the amount of electricity consumed during the operation of lighting:

$$E_1 = \Sigma\left(n_I * N_{LI} * T_{PI}\right), \left[kWh\right] \qquad (1)$$

where:

n_I – number of lighting fixtures of equal power, [piece].

N_{LI} – Power using the same lamps, [KW];

T_{PI} – number of hours per year, [hours].

Determination of fuel for electricity used for lighting:

$$B_1 = E_1 * \left(1 + k_{LN}/100\right) * b_{ee} * 10^{-6}, \left[t\right] \qquad (2)$$

where:

b_{ee} - specific fuel consumption for electricity generation is taken as the actual consumption of fuel by closing the station in the power system for the year, prior to performing the calculation, [t/kWh];

k_{LN} - coefficient taking into account the losses in electric networks.

When the electric power required for lighting of the closing station is received with the power loss in electric networks.

- Determination of fuel consumption when using fluorescent lamps with electronic control gear.

- Determination of the amount of electricity consumed when the working lighting uses lighting devices with automatic adjustment of the light flow:

$$E_2 = \sum\left(k_I * \left(1 - 0{,}3\right) * N_{ELI} * T_{PI} \right), \left[t/kWh \right] \qquad (3)$$

where:

k_I - number of energy-efficient lighting products of equal power, [piece].

N_{ELI} - the power to apply the same lighting with an automatic adjustment of capacity; [kWh]

T_{PI} - the number of hours per year, [hours].

Reducing the energy consumption of lighting fixtures by automating up to 30%, of which 10% - at the expense of maintaining the level of illumination on the 500[lx] without reserve, 20% - by automatically regulating the light flux relative to the natural lighting.

- Determination of fuel for electricity used for lighting:

$$B_2 = E_2 * \left(1 + k_{LF}/100\right) * b_{ee} * 10^{-6}, \left[t \right] \qquad (4)$$

where

b_{ee} - specific fuel consumption for electricity generation is taken as the actual consumption of fuel by closing the station in the power system for the year prior to performing the calculation, [y s.f./kWh];

k_{LF} - coefficient taking into account the losses in electric networks, [%].

When the electric power required for lighting of the closing station is received with the power loss in electric networks.

- Determination of the fuel economy of the implemented measures:

$$dB = B_1 - B_2, \left[t \right] \qquad (5)$$

4. CALCULATION OF MERCHANTABILITY FOR THE IMPLEMENTATION OF ENERGY SAVING LIGHTING EQUIPMENT WITH AUTOMATIC ADJUSTMENT

- Definition of consolidated investments [2];

- The cost of equipment C_{ob} is determined according to the agreed prices (based on the tender);
- The cost of design work C_{smp} - up to 10% of the value of construction works;
- The cost of construction and installation works - 25-30% of the cost of the equipment;
- The cost of commissioning - 3-5% of the cost of the equipment.
- Investments in the event:

$$K_{op} = C_{ob} + 0{,}1 * C_{smp} + (0{,}25 - 0{,}3) * C_{ob} + (0{,}03 - 0{,}05) * C_{ob}, \left[thousand\ levs \right] \qquad (6)$$

- Determination of payback measures at the expense of fuel economy:

$$C_t = K_{op} / \left(dB * C_{te} \right), \left[years \right] \qquad (7)$$

where:

K_{op} - investment in the event, [thousand levs];

dB - fuel economy of the introduction of measures [t];

C_{te} - cost of 1 ton of coal equivalent (thousand levs) is specified at the time of calculation.

5. DESCRIPTION OF THE PROGRAM ALGORITHM TO CALCULATE THE ENERGY SAVINGS.

This algorithm is described by means of a flowchart and is implemented with the programming language MatLab [1, 3]. After starting the program we enter the number (1, 2, 3, ... 7) of the used assessing energy - saving methodology (fig. 1). Each method corresponds to a subroutine that is executed and the results are displayed on the operation of the subroutine. If necessary, we perform another subroutine. After completion of the work, all the results are displayed.

All variables used in the program, and the entire session working with the program are stored in a separate file that can be opened, viewed and printed.

The program is easy to process data necessary to implement methodologies that aim to demonstrate the implementation of individual measures or groups of measures to improve energy savings.

The above program is useful in the post-implementation of energy efficiency measures. On the basis of the accumulated database we can more accurately assess the real impact of the measures – the actual temperature maintained in the building in terms of the design temperature and depending on the outside temperature, fuel coolant, etc. On this basis, a complete analysis can be done and the planned project burning characteristics and achievements in the actual operation can be compared. The certificate issued within the period provided by accordance with the energy efficiency regulations would have a solid justification of factual data.

ISSN 1313-2539, Published at: http://www.scientific-publications.net

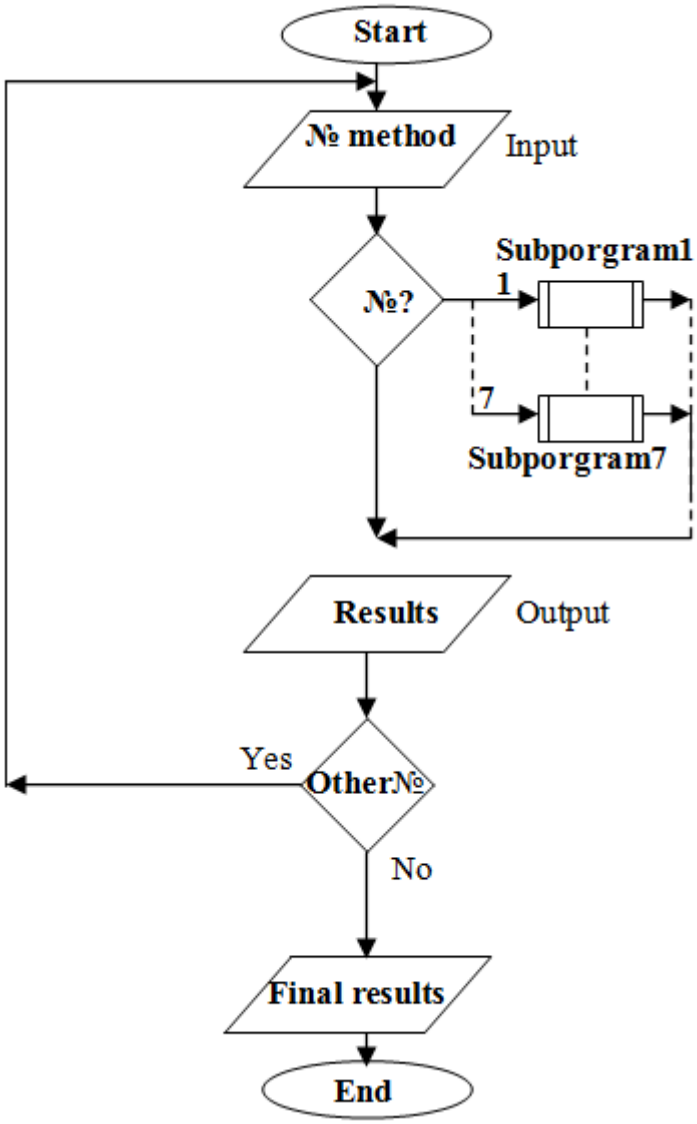


Fig. 1. Flowchart of the program to calculate the energy savings

6. DESCRIPTION AND IMPLEMENTATION OF ALGORITHMS TO CALCULATE THE SAVINGS FROM THE ECONOMIC EFFECT OF THE USE OF ENERGY - EFFICIENT AUTOMATIC LIGHTING DEVICES

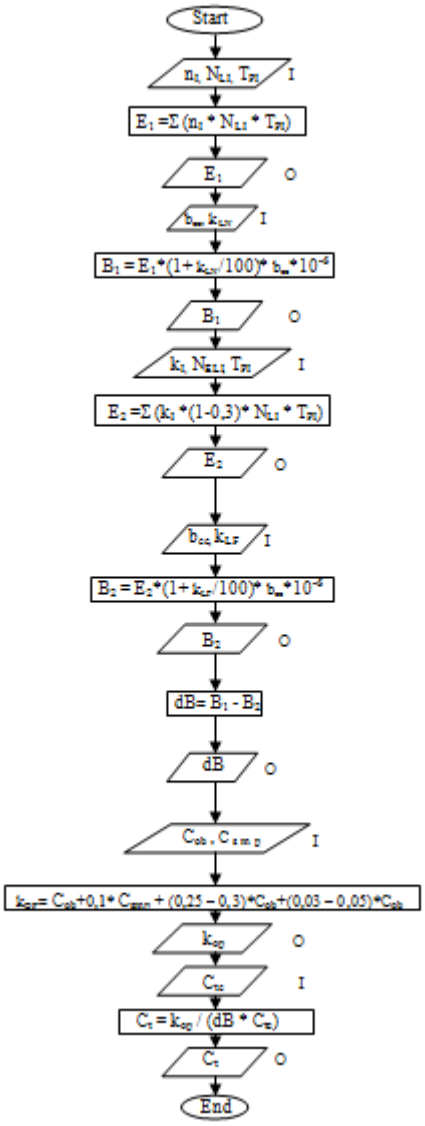


Fig. 2. Flowchart of the program to calculate the savings from the economic effect of the use of energy-efficient automatic lighting devices. I-input, O-output

An algorithm was developed in order to calculate the savings from the economic effect of the use of energy-efficient automatic lighting devices (Fig. 2). The algorithm is described by a flowchart and is implemented with the programming language system for scientific and engineering calculations MatLab [1, 3].

MatLab is based on a matrix representation of the data. It contains tools, including data processing, operations on matrices, vectors, polynomials, complex numbers, signal analysis, digital filtering, two-dimensional and three-dimensional graphics, etc. [9, 10]. It is applied to various fields of science and technology. MatLab is open, flexible and easy to apply to the solution of a specific problem.

The sequence of steps of the algorithm is:

Input:

n_I – number of lighting fixtures of equal power, [piece].

N_{LI} – Power used the same lamps, [KW];

T_{PI} – number of hours per year, [hours].

It calculates and displays the amount of electricity E_1 consumed during the operation of lighting, formula (1).

Input:

b_{ee} – the specific fuel consumption for electricity generation is taken as the actual consumption of fuel by closing the station in the power system for the year, prior to performing the calculation, [t/kWh];

k_{LN} - coefficient taking into account the losses in electric networks.

It calculates and displays the fuel for electricity B_1 used for lighting, formula (2).

Input:

k_I - number of energy-efficient lighting products of equal power, [piece].

N_{ELI} - the power to apply the same lighting with automatic adjustment of capacity; [kWh]

T_{PI} - the number of hours per year, [hours].

It calculates and displays the amount of electricity consumed when the working lighting uses lighting devices with automatic adjustment of the light flow E_2, formula (3).

Input:

b_{ee} – the specific fuel consumption for electricity generation is taken as the actual consumption of fuel by closing the station in the power system for the year prior to performing the calculation, [y s.f./kWh];

k_{LF} - coefficient taking into account the losses in electric networks, [%].

It calculates and displays the fuel for electricity used for lighting B_2, formula (4).

It calculates and displays the fuel economy of the implemented measures dB, formula (5).

Input:

- The cost of the equipment C_{ob} is determined according to the agreed prices (based on the tender);

- The cost of design work C_{smp} - up to 10% of the value of construction works;

It calculates and displays investments in the event, formula (6).

Input:

C_{te} - cost of 1 ton of coal equivalent (thousand levs) is specified at the time of calculation.

It calculates and displays the payback measures at the expense of fuel economy C_t, formula (7).

7. ADVANTAGES OF THE ALGORITHM FOR EVALUATION OF ENERGY SAVINGS

The information technology assessment of energy savings and its algorithm have advantages and disadvantages. Some of the advantages are:

- in the accumulation of a sufficiently large database, the real impact of energy savings on the use of automatic energy-efficient lighting devices can be assessed very accurately;

- using the database, a complete analysis can be made and the planned project and the achieved energy performance in the real operation can be compared;

- the certificate issued within the period provided in accordance with the energy efficiency regulations in force would have a solid justification of factual data.

- it is easy to handle and calculate the data required for the application of the methodology, which aims to demonstrate the implementation of individual measures or groups of measures to improve energy savings of the use of automatic energy-efficient lighting devices with information technology.

8. CONCLUSION

Information technology, data processing, the evaluation and calculation of energy savings is a good and convenient way to control and objectively analyze the impact of the application of energy efficiency measures on the use of automatic energy-efficient lighting devices. In applying such an information technology for calculating the energy savings of the use of automatic energy-efficient lighting devices, high reliability, easy transfer and data processing can be achieved.

The availability of data and the possibility of collecting and processing them is essential for accurate and fair assessment of the energy savings in the developed methodologies. It is important to have the most accurate information and data before any assessment.

Information technology should be used in each of the methodologies for energy savings. Energy-saving systems are focused on efficient energy use through innovative technologies. In modern industry, it integrates flexibility, functionality, aesthetics, environmental and energy efficiency.

REFERENCES

[1]. Chen C., P Dzhibling A., Irving, MatLab in mathematical research, Moscow, Mir, 2001.

[2]. Department of Energy, Ministry of Economy of the Republic of Belarus, 2008

[3]. Dyakonov V. P, MatLab 6: Training Course, St. Petersburg, 2001.

[4]. http://www1.bpo.bg/images/stories/buletini/ binder-2012-09.pdf

[5]. http://www.eulaw.egov.bg/DocumentDisplay.aspx?ID =382929

[6]. http://www.climamarket.bg/

[7]. http://www.mi.government.bg/files/useruploads/files/microsoft_word-metodiki.pdf

[8]. Microsoft Office 2007, Софт Прес, 2007

[9]. Tonchev J., Matlab 7, Part I, Transformations, calculations, visualization technique, Sofia, 2010

[10]. www.mathworks.com