ENERGY PERFORMANCE OF BUILDINGS

Daniel Hlubeň, Ľubomír Beňa

ABSTRACT

The paper entitled "Energy performance of buildings" deals with the new standard prEN 15 193. The main goal of this standard is to assess energy consumption of lighting in a building and minimize energy consumption of lighting.

1 INTRODUCTION

According to the aim of European Union to improve efficiency of electric energy consumption, several standards were published during last year. [1]

The main goal of these standards is to assess energy consumption. Buildings assessed according to this methodology are divided into several groups (A, B, …., G), according to the efficiency of the whole building. This assessment includes several fields and the lighting is one of these fields.

This article describes briefly prepared standard for energy performance of buildings – "Energy requirements for lightning".

2 ENERGY REQUIREMENTS FOR LIGHTING

The main goal of this standard is to establish conventions and procedures for the estimation of energy requirements of lighting in buildings and to give a methodology for a numeric indicator of energy performance of building. [2]

At the beginning, it is necessary to write, that there are several methods, how to assess energy performance:

- Quick method
- Comprehensive method
- Measurement of lighting circuit

Methods division can be seen on figure 1.

2.1 Quick method

Quick method uses for the LENI index calculation the following formula

$$LENI = \{F_C \times P_N/1000 \times [(t_D \times F_D \times F_O) + (t_N \times F_O)]\} + 1 + \{5/t_y \times [t_y - (t_D + t_N)]\}\ [kWh/(m^2 \times year)]$$

P_N Total installed lighting power in the room or zone
F_c Constant illuminance factor
t_D Daylight time usage [h]
t_N Non-daylight time usage [h]
t_y Standard year time
F_O Occupancy dependency factor
F_D Daylight dependency factor

It is necessary to emphasize that this method is for fast calculation only and LENI index is usually higher. This calculation has an informative character.

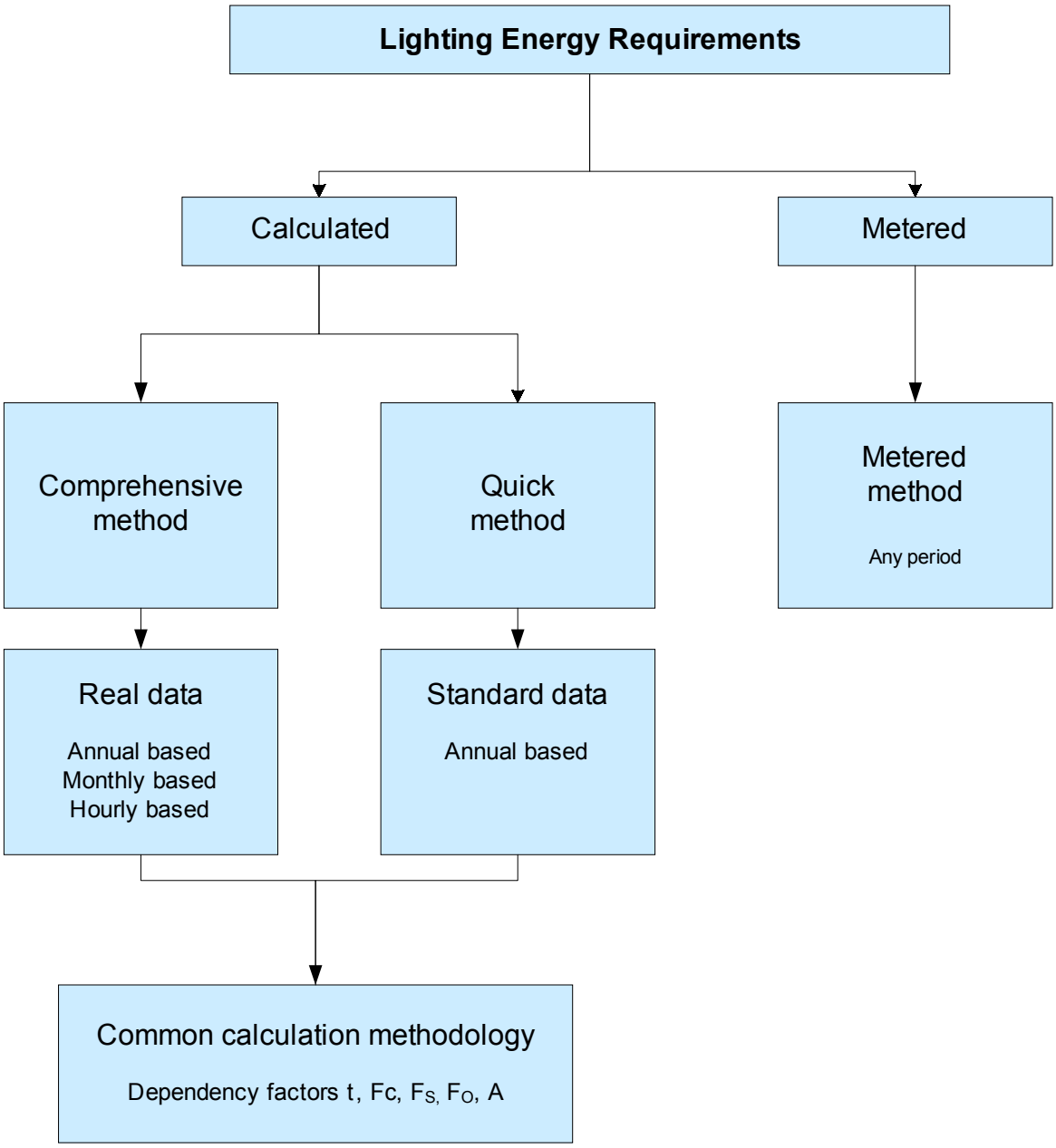

Figure 1 – Flow chart illustrating alternative routes to determine energy use

2.2 Comprehensive method

This method is more complicated. It is out of range of this article to describe this method into depth, therefore there are showed only some factors, which are taken into account

- Daylight area (a zone receiving daylight)

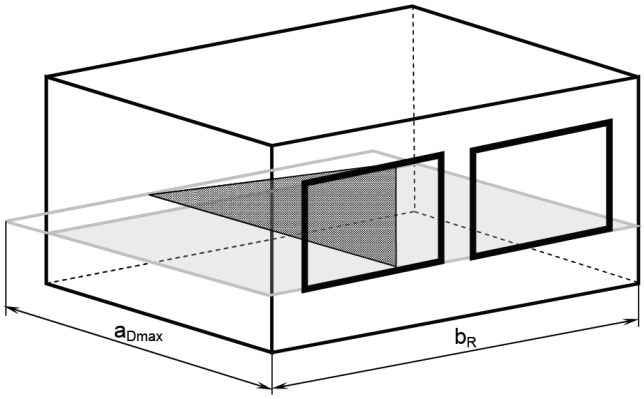

Figure 2 – Daylight area (a_{Dmax} x b_R)

- Rooflights (e.g. glass pyramid, glass roof window, glass ridge, polycarbonate ridge, polycarbonate pyramid, polycarbonate dome)
- Obstructions

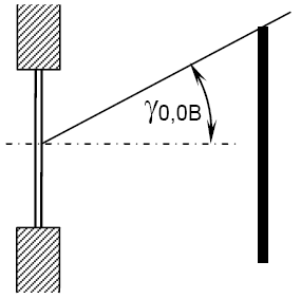

Figure 3 – Obstruction caused by e.g. another building

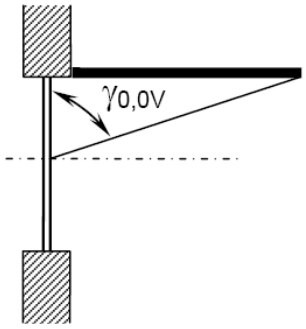

Figure 4 – Overhang

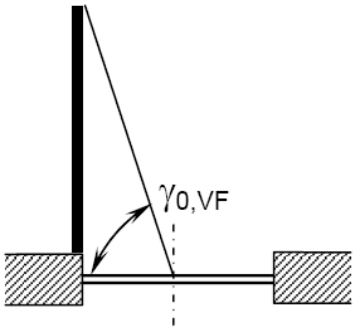

Figure 5 – Vertical fin

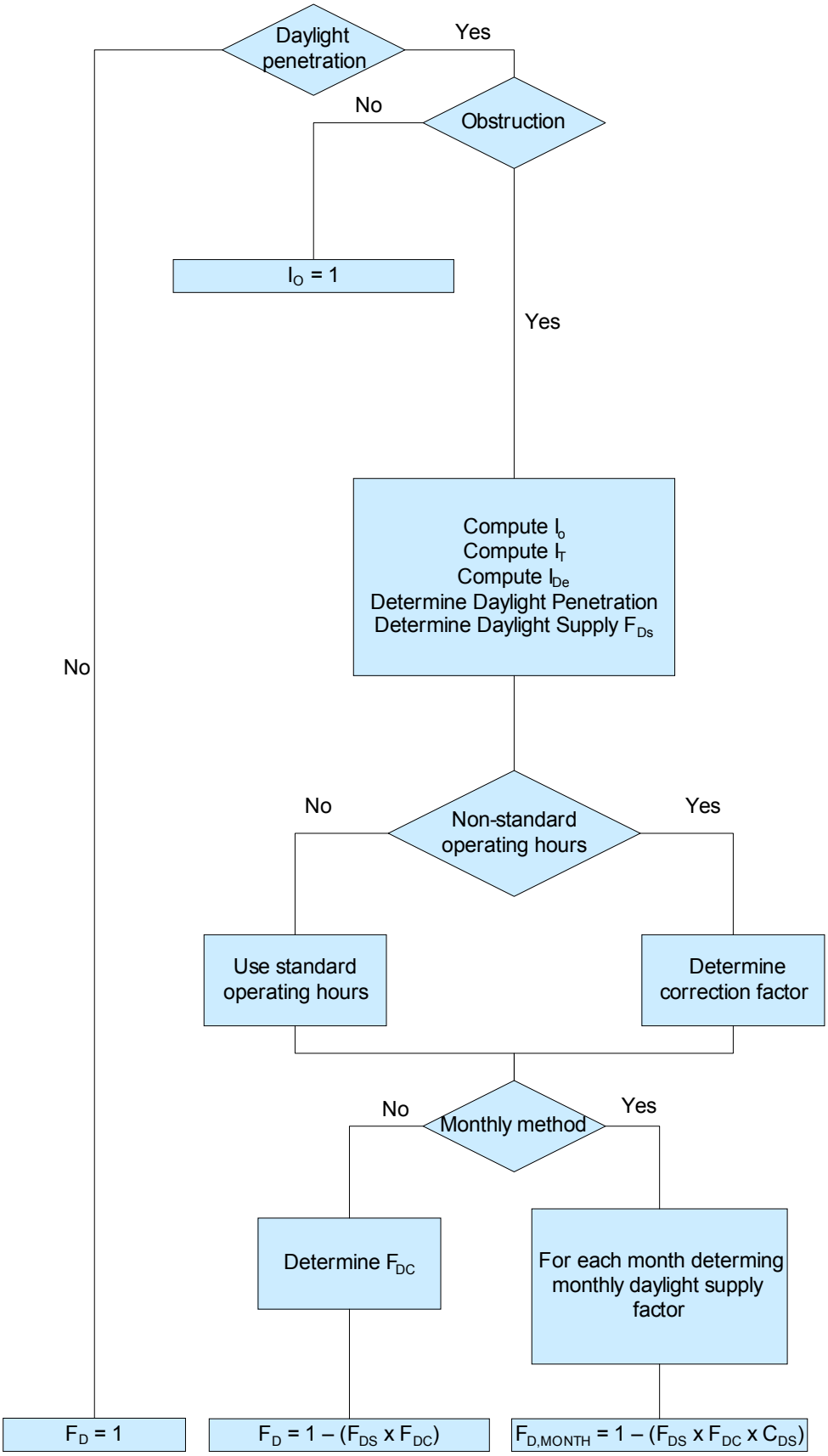

Figure 6 – Flow chart illustrating the determination of the daylight dependency factor $F_{D,N}$ in a zone.

2.3 Measurement

The lighting consumption shall be separately measured using one of the following methods:

a) kWh meters on dedicated lighting circuits in the electrical distribution;
b) local power meters coupled to or integrated in the lighting controllers of a lighting management system;
c) a lighting management system that can calculate the local consumed energy and make this information available to a building management system (BMS);
d) a lighting management system that can calculate the consumed energy per building section and make this information available in an exportable format, e.g. a spread sheet format;
e) a lighting management system that logs the hours run, the proportionality (dimming level) and relates this to its internal data base on installed load.

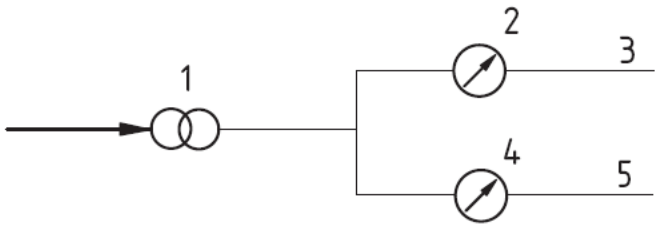

Figure 7 – Measurement

Then we have, that

$$W = W_{\text{light metered}}\ [\text{kWh/year}]$$

3 LENI CALCULATION

Lighting Energy Numeric Indicator for the building

$$LENI = W/A\ [\text{kWh}/(\text{m}^2 \times \text{year})]$$

But it is necessary to emphasize, that this LENI index is valid, if standards like EN 12 464-1 are fulfilled. This indicator does not take into the account different rooms (area) and their lighting.

Therefore it is necessary to define new variables, which will take it into account, and the resulting index will be e.g.

$$W_E = \frac{W}{\sum E_m \cdot A}$$

But real (measured) illumination could be lower than required illumination. The following formula takes it into the account:

$$W_{E'} = \frac{W}{\sum_{i=1}^{n} E_{m,i} \cdot A_i \cdot \eta_{o,i}} = \frac{W}{\sum_{i=1}^{n} E_{mes,i} \cdot A_i}, \quad \left[\frac{\text{W}}{\text{m}^2.\text{lx}}, \text{W}, \text{m}^2, \text{lx}\right]$$

$$\eta_{o,i} = \frac{E_{mes,i}}{E_{m,i}}, \quad [\text{-}, \text{lx}, \text{lx}]$$

Where

$E_{m,i}$	required (maintained) illumination for the room [lx]
$E_{mes,i}$	measured illumination [lx]
$\eta_{o,i}$	factor taking into the account requirements of the standard EN 12 464 – 1
A	area [m^2]
W	lighting consumption

And finally, according to this factor it is possible to suggest energy saving measures.

4 CONCLUSION

This article briefly described methods of the LENI index calculation, but at the end of this article authors have dealt with problem of lighting efficiency calculation. This type of calculation is not taken into account and it will be necessary to add similar factor and classification into the standard.

5 REFERENCES

[1] DIRECTIVE 2006/32/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC
[2] PrEN 15193: Energy performance of buildings — Energy requirements for lighting
[3] EN 12464-1, Light and Lighting – lighting of workplaces – Part 1: Indoor work places

Author address:

Ing. Daniel Hlubeň
Department of Electric Power Engineering
Technical University of Košice
Mäsiarska 74
040 01 Košice, Slovak Republic
E-mail: daniel.hluben@tuke.sk
Tel: +421 / 55 / 602 3559
Fax: +421 / 55 / 602 3552

Ing. Ľubomír Beňa, PhD.
Department of Electric Power Engineering
Technical University of Košice
Mäsiarska 74
040 01 Košice, Slovak Republic
E-mail: lubomir.bena@tuke.sk
Tel: +421 / 55 / 602 3555
Fax: +421 / 55 / 602 3552