Forgotten issues in Energy Saving

HANS J. JACOBSEN
M.Sc., Philips Lys A/S, Prags Boulevard 80, DK-2300 Copenhagen, Denmark

ABSTRACT

CFL-LAMPS, HF, DAYLIGHT DIMMING, and intelligent lighting systems are topics in focus when talking about energy saving in lighting. This paper focuces on two subjects out of focus, where maintained or improved lighting quality can be combined with important savings in energy.

FORGOTTEN ISSUE 1: MAINTENANCE ASPECTS OF LIGHTING INSTALLATIONS

Indoor and outdoor lighting installations are designed on basis of standards and recommendations stating the required illuminance or luminance level for the specific application. These figures are to-day given as maintained values, meaning the lowest level allowed in the installation which is normally found just before a systematic cleaning and replacement of lamps.

If the recommendation is 300 lux for e.g. a school classroom the initial value in the new installation has to be higher – may be 400 lux – to ensure the 300 lux at the critical time just before lamp replacement and cleaning.

The ratio between the maintained and the initial value is the maintenance factor MF. With above mentioned values MF is 300/400 = 0.75.

As the number of installed lamps and luminaires–- and conse-quently the energy consumption –- is defined by the initial needed lux value, it is clear that the maintenance factor MF is essential for the energy consumption.

An MF value of e.g. 0.5 instead of e.g. 0.7 will give 40% higher energy consumption during the whole lifetime of the lighting installation. In spite of the essential role of the maintenance factor the handling of it in practice is often very unprofessional, and improving around this is certainly a potential for energy saving, better economy and quality of light.

The maintenance factor is depending on:

Lamp data	Lumen maintenance curve Lamp survival curve
Dirt aspects	Luminaire Room Surroundings
Maintenance procedure	(Spot replacement or group replacement and time between group replacements)

COST CALCULATION PROGRAM FOR EVALUATION OF OPTIMAL MAINTENANCE PROCEDURE AND LAMP SELECTION.

Lumicon is a PC-program developed with the purpose of optimalizing procedure for maintenance and the best lamp choice in relation to both economy and energy consumption.

The calculations are based on lumen maintenance curves and lamp survival data for the actual lamps.

In Lumicon the user specifies cost of kWh, luminaire, lamp replacement and cleaning etc. together with the maintenance procedure (see figure 1). As a result key figures for cost per 100 lux/m^2/year are produced, and this can be taken as a relative description of the total cost of the lighting installation. Furthermore the resulting maintenance factor is given, and consequently the key factor for

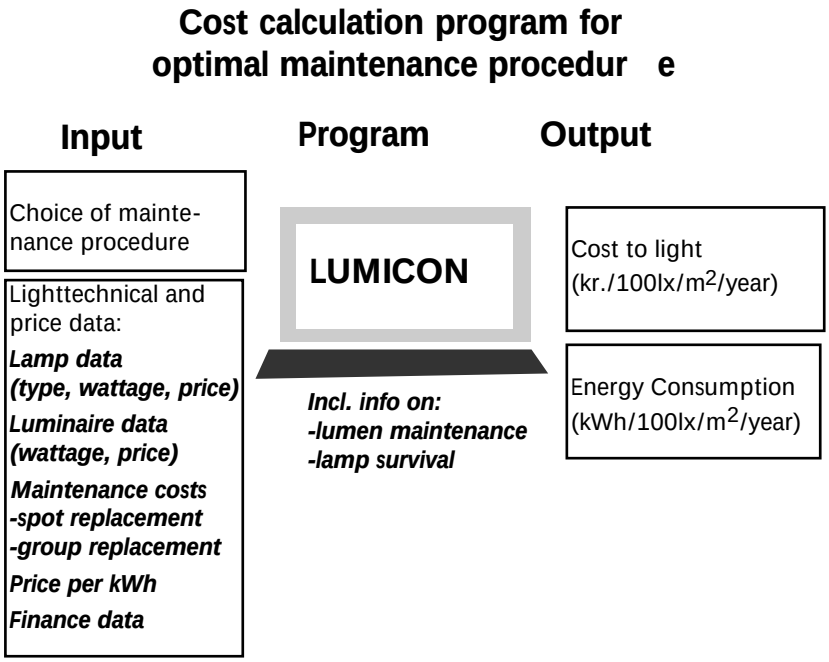

Figure 1. When maintenance procedure is specified with lighttechnical data and costs, the LUMICON--program gives the total costs and yearly energy consumption.

Table 1. Input for calculations with new installaton with costs to lamps, installaton labour, etc.

Maintenance in new installation

Input	**Tri-phosphor lamp**	**Halo-phosphate lamp**
Illuminance, maintenance	200 lux	200 lux
Price per kWh	1,00 kr	1,00 kr
Number of lamps per luminaire	1 pc.	1pc.
Lamp lumen	3350 lm	2850 lm
Lamp Ra	85	63
Lamp W	36 W	36 W
Loss of W in components	8 W	8 W
Dirt group	A/B	A/B
Yearly burning hours	2.500 hours	2.500 hours
Price Data		
Luminaire price	816,25 kr	816,25 kr
Lamp price	68,15 kr	35,00 kr
Installation costs per luminaire	440,00 kr	440,00 kr
labour costs per lamp replacement:		
Spot replacement		
Group replacement	40,00 kr	40,00 kr

energy consumption in kWh per 100 lux/m^2/ year.

With this program it is possible to make evaluations both for new and for existing lighting installations. For different lamp types it can be tested if spot replacement or group replacement is best. In that connection the optimal period between group replacements can also be found..

EXAMPLE OF EVALUATION OF MAINTENANCE PROCEDURE AND CHOICE OF LAMP TYPE FOR A NEW LIGHTING INSTALLATION.

To illustrate the importance of lamp type and maintenance procedure calculations have been made for a typical indoor installation with fluorescent lamps. It is supposed that the location is in rather clean surroundings and that the yearly burning hours are 2500 hours.

When lamps are group replaced, the luminaires are cleaned at the same time. If lamps are failing between group replacements these are spot replaced at once. The assumptions are given in tab. 1.

The number of lamps and luminaires are chosen to give an average maintenance illuminance on 300 lux in the room.

In fig. 2 the maintenance factor is shown as function of time between group replacements for halophosphate

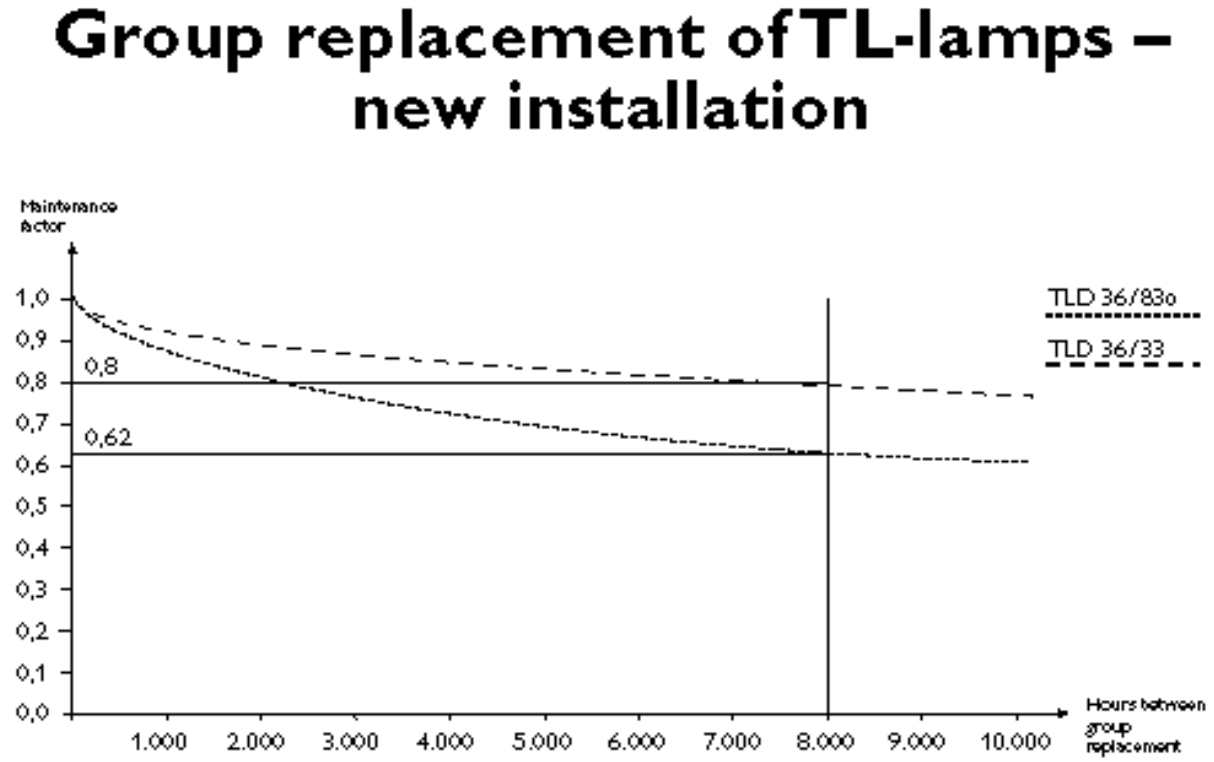

Figure 2. Maintenance factor for new generation tri-phosphor (TLD 36(83o) and halo-phosphate (TLD 36/33) in lighting installation in dirt group A/B /Clean.

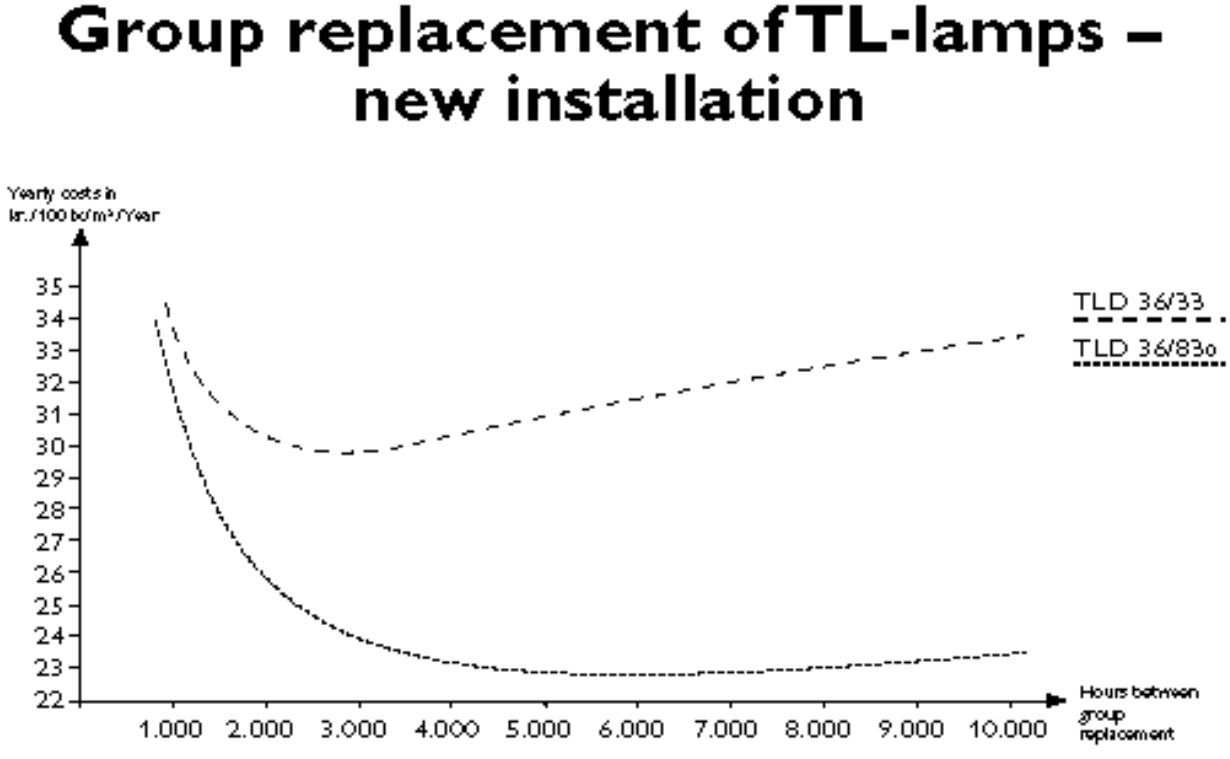

Figure 3. Yearly costs for new lighting installation with tri-phosphor or halo-phosphate fluorescent lamps.

lamps (standard fluorescent lamps) and for new triphosphor lamps, having a low content of mercury.

It can be seen that the maintenance factor for new generation triphosphor lamps is higher than for standard lamps for all group replacement intervals. As dirt effect and lamp survival curves are identical for mentioned lamp types the difference is only caused by a much better lumen maintenance for the triphosphor lamps.

With a replacement interval on i.e. 8.000 hours, MF is 0,62 for standard lamps and 0,80 for triphosphor lamps. It means that the energy consumption will be 30% higher with standard lamps compared to triphosphor lamps when a new lighting installation is designed with correct MF-values.

It is clear that MF-values will increase and energy consumption decrease with shorter lamp replacement intervals. From an economical point of view this has to be balanced against higher costs for lamps and replacements. Fig. 3 shows the economical effect of different group replacement intervals. It can be seen that for standard lamps the most economical interval is very short, but for triphosphor lamps 8.000 hours are reasonable.

Fine tuning the handling of maintenance factors in the design phase with reasonable choice of lamp type and maintenance procedure will in general improve quality and decrease energy consumption and costs.

In a theoretical calculation based on fixed quality requirements the energy saving in lighting installations with fluorescent lamps can be on a level of 15-20% by remembering this forgotten issue.

FORGOTTEN ISSUE 2: ENERGY SAVING ALTERNATIVES IN SHOP LIGHTING

When the subject is energy saving in lighting and lamp possibilities in this connection there can be a tendency in some circles only to think of CFL lamps. The CFL lamp is an obvious alternative to incandescent lamps in private homes, and in many countries big campaigns have been running to tell the consumer that good and correct story. It is, however, often forgotten that other new lamp types are just as efficient - or even more - than the CFLs and that some of these can be better alternatives to existing practice.

Based on ref. [1] ("Teknologikatalog - energibesparelse i erhvervslivet") it can be estimated that about 30% of electricity consumption outside private homes is spent in shop lighting. In this very important segment fluorescent lamps, incandescent lamps and halogen incandescent lamps are the most used lamps, and in the last years especially the halogen incandescent lamps have been very popular and often used for general lighting as well as for spot lighting mainly in the high-end shops.

Thinking of energy-efficient shop lighting CFL can, to a certain extent, be used , but to create a real, exiting and selling presentation of goods a lamp with a higher luminance is often needed to give brilliance and sparkling effects. The halogen incandescent lamps are in this respect strong, and combined with the small dimensions this is the reason for the popularity of these lamps.

What can be claimed as a forgotten issue, however, is that there are today good alternatives to the halogen lamps in shop lighting applications with a much lower energy consumption.

The requirements for a lamp for general lighting and spot lighting in shops are: good colour-rendering (Ra>80), compact dimensions making spot lighting possible and a high luminance to give brilliance and sparkling effect. Below is a list of lamp types that fulfil these requirements with their corresponding efficiency expressed in lm/W:

	lm/W
Incandescent lamps	8-16
Halogen Incandescent lamps	12-24
Super High Pressure Sodium	39-48
Ceramic Metal Halide	81-86

If as a rough estimate the amount of light (lumen) produced by halogen incandescent lamps in shop lighting is 20% of total and the rest – to a great extent – is fluorescent lighting, the power consumption of halogen will roughly be 50% of total. Supposing that 25% of the halogen light can be transferred to ceramic metal halide and super high pressure sodium lamps the energy saving potential will be 10% of energy used for shop lighting!

CONCLUSION IS THEREFORE:

1) Shop lighting segment is a heavy energy user. (Roughly 30% of electricity consumption for light outside private homes).

2) It is possible with modern technology to reduce power consumption by at least 10%, having at the same time a very attractive and selling lighting system.

It is a challenge for all parts involved in planning of shop lighting – eventually inspired by info-campaigns from public authorities – to transfer this forgotten issue into practice. ●

REFERENCES

1) Teknologikatalog – energibesparelser i erhvervslivet. Miljø- og Energiministeriet, Energistyrelsen, DK