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ENERGY LABELING IN ELECTRICAL LAMPS AND EFFECTS IN LOAD MANAGEMENT IN IRAN

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ABSTRACT:

The electrical lamps are among the equipments which have a high rate of consumption in home, administrative, commercial, and industrial and public sectors at the national level. Due to the fact this tool is used mostly at the peak hours, it consumes a great part of the electrical energy at the peak hours. In order to reduce the electrical energy consumption at the peak hours, it is essential to use low output lamps instead of low output lamps. Therefore, it is essential to have lamps with the label of energy consumption. In this paper, in order to label the lamps, first an index was defined and then on the basis of that index, the lamps were labeled.

Key Words: The intensity of the lighting in terms of LUX (E), Lighting output of the lam in terms of LUMAN Per Watt (LPW), the lighting output of the base in terms of LUMAN Per Watt ref), Index of Lamp Performance ((I), Lighting Flux produced by Lamp in terms of LUMAN (Q), The Input Power of the Lamp in terms of Watt (W).Load Management

Introduction:

The rate of the electrical energy consumption in the lighting sector from the load peak of the network in Iran is 40%. So in line with the Third Development Plan , determining the indexes , developing the standards , making energy consumption labels and presenting approaches to improve the performance of the kinds of electrical lamps including incandescent lamps, fluorescent and gas discharge for the purpose of reducing the consumption of electrical energy is unavoidable. In line with this objective, it is necessary to determine a reliable index of energy consumption and then on the basis of that criteria, the lighting equipments to receive consumption labels. In this paper, we are searching for a creditable index to determine the energy consumption of the lamps and compare them with each other. By using the determined index, we will deal with the division of the lamps and will classify them, before reviewing these indexes and ranking the lamps, it is essential to investigate the necessity of using these labels. We will deal with this important issue in the continuation of this paper.

The necessity of developing energy consumption labels for electrical lamps

Replacing the high output lamps with low output lamps is one of the most effective ways to improve the performance of lighting system from the view point of the energy consumption . In this discussion, we will deal with the effect of using high output lamps instead of low output lamps on energy consumption. For this purpose, the following assumptions have been considered:

1. The 18-Watt lighting flux of the compact fluorescent lamps (CFL) and the 100-Watt incandescent .lamps is equal.
2. The CFL lamps needs ballast for running and the 5 Watt ballast consumption power has been considered for 18-Watt CFL, so the total lamp consumption power and CFL ballast will be equal to 23 Watt.
3. The rate of the time of lamp being in the state of on is assumed to be in average one hour per day.
4. The lifetime of 100-Watt clear incandescent lamp is assumed as 1000 hours and the CFL and its ballast as 5000 hours.
5. The primary price of the incandescent lamp is considered as 2500 Rails and a CFL lamp along with ballast is assumed as totally 27000 Rails.
6. The annual inflation rate is assumed as equal to 10 percent.

With regard to these assumptions, the cost of one hour of on state of the CFL lamp has been compared with the one hour of on state of the 100-Watt incandescent lamp.

The annual cost of one hour of on state of the lamp can be divided into three parts. These three parts include: the cost of one hour electrical consumption of $ALCC_{Elec}$

(Annualized-Life-Cycle Cost Elect), the cost of one hour using the lamp or $ALCC_{Lamp}$ and the cost of one hour using ballast (in the case of CFL lamps) or $ALCC_{Ballast}$, so we will have:

$$ALCC_{Total} = ALCC_{Elec} + ALCC_{Lamp} + ALCC_{Ballast}$$

ALCC are calculated as follows:

1. Calculation of the length of the period under investigation

N (yr) =Lifetime (hr)/ Yearly Usage (hr/yr)

2. Calculation of the co-efficiency of the present value

Periodical payment of Pa

$$P_a = (1+i) * ((1+i)^n - 1)) / i$$

Which i is the rate of annual inflation?

3. Calculation of the ALCC's

$$ALCC_{Lamp} = \frac{\text{Initial Cost(Rls)}}{P_a} \text{(Rls/year)}$$

$$ALCC_{Ballast} = \frac{\text{Initial Cost(Rls)}}{P_a} \text{(Rls/year)}$$

$$ALCC_{Elec} = (P_l + P_B)CT \quad \text{(Rls/year)}$$

Which P_l is the consuming power of the lamp, P_B is the ballast consuming power, C is the cost of electricity per year and T is the period of using per year. The following Table is the cost of one hour using 100-Watt incandescent lamp and an 18-Watt CFL lamp by division.

Table (1): Comparing the price one hour 100-Watt incandescent lamp and a 18-Watt CFL lamp

Description	(GLS)	(CFL)
Lamp consuming power (W)	100	18
Ballast consuming power (W)	-	5
Lamp lifetime (hr)	1000	5000
Ballast lifetime (hr)	-	5000
Lamp price (RIs)	2500	9000
Ballast price (RLs)	-	18000
Annual electrical consumption cost (RIs/yr)	5475	1259
Lamp lifetime (yr)	2.74	13.7
Ballast lifetime (yr)	-	13.7
Co efficiency of the lamp present value	3.28	29.6
Ballast present value co efficiency	-	29.6
Lamp life cycle cost (RIs/hr)	2.1	0.8
Ballast life cycle cost (RIs / hr)	-	1.7
Consuming electricity cost (RIs/hr)	15	3.5
Total life cycle cost (RIs/hr)	17.1	5.9

The results of the Table (2) shows that each incandescent lamp (low output) has a cost as three times of a fluorescent lamp (high output). The consumption of electrical energy of an incandescent lamp is about 5 times of that of a fluorescent lamp. Since lighting has allocated a great part of the consumption of electrical energy to itself , so using the low consuming lamps will bring about a great deal of saving in the consumption of electrical energy in particular at the peak hours . This subject indicates the necessity of developing the standards of the energy consumption of the electrical lamps.

The index of energy consumption and raking of the lamps

The index of energy consumption is a criterion to compare the lamps with each other. The objective of this paper is to determine this index. This index should be determined such that it considers both the input power and lighting flux of the lamp. Thus the best option which could encompass both parameters is lighting output.

The two basic problems in this way is that first the difference of lighting output of the lamps which have one technology in different powers. And the other problems is the existence of different technologies of electrical lamps (incandescent, fluorescent, CFL and gaseous). At the end, we will deal with these problems. The tests conducted on different lamps shows that the lighting output of the lamps in different powers are different. Figure (1) shows the lighting output of the incandescent lams which has been obtained by the test.

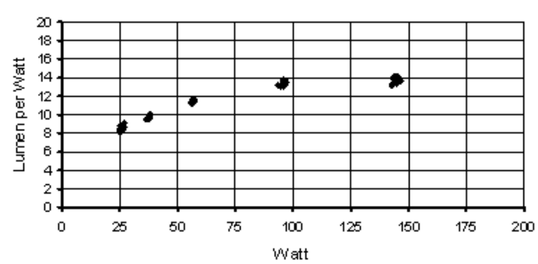

Figure (1). Lighting output of the incandescent lamps in different powers

This figure shows that the lighting output of different incandescent lamps have high difference in different powers. So the lighting output can not be a good index for the comparison of the lamps. Since this subject cause the low consuming lamps to be placed in higher ranks and it encourages the consumers to use high consumption lamps. One of the solutions to determine the new index is using the lighting index which is defined as follows:

$$I = \frac{LPW}{LPW_{ref}}$$

In this relation, LPW_{ref} is the base lighting output? A question which is put forward here is the method of determining the lighting output base which could respond to both problems. Concerning the above explanations, the base lighting output should be subject to two parameters:

1. The base lighting output should be subject to lamp consumption power.

2. The base lighting output should be subject to the technology of the lamp.

So, the lamps with different powers and technologies should be tested and their lighting output to be measured. Then with the help of the conducted measurement, the base lighting output base will be obtained as a function of power and technology. For this purpose, some testes were carried out on lamps with different incandescent technologies, fluorescent, CFL and different gashouse lamps. With regard to the obtained results from different tests, LPW ref will be obtained from the following relations:

$$LPW_{ref} = 0.0297W + 9.3466$$

After determining the index, they should be ranked.

Lamps classification

In order to determine the label of the energy consumption of the lamps, it is necessary that after determining the indexes, the lamps to be classified. The lamps classification should be such that the producers do not receive any overburden and also reduces the consumption of the electrical energy. In order to determine these classes, the determination of LPW of different lamps can be used. Figures No. 3, 4, and 5, shows the results of lamps with different technologies and powers. The mentioned codes on figures indicate the code of the lamp producing factory. Concerning these figures, the following Table is obtained to classify the lamps.

Table 2. Non-gaseous lamps classification on the basis of the limits of I index

The limit of the index I	Class
A	10<I
B	5<I<10
C	2.5<I<5
D	1.2<I≤2.5
E	0.9<I ≤1.2
F	0.8<I<0.9
G	0.7<I<0.8
NO GRADE	I<0.7

Algorithm

The Algorithm of the determination of the lamps classification is as follows:

1. The measuring of the lighting flux and consumption power of the lamp on the basis of the reference standards by authorized institute (Institute of Standard and Industrial Researches)

2. Calculation of the LPW ref with regard to the following formula :

$$LPW_{ref} = 0.0297W + 9.3466$$

3. Calculation of the I index

$$I = 100\frac{LPW}{LPW_{ref}}$$

The figure 100 was used for enlarging the index figure.

4. Determining the rank of the lamp

After determining the class of the lamps, the label figure (2) can be used for labeling the lamps.

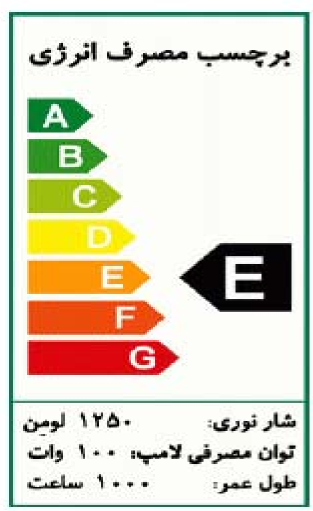

Figure (2) Energy labeling in electrical lamp

Effect of energy labeling in peak load

Energy labeling in electrical lamp reduce
Peak load and has energy saving.
Estimates show that %1.8 peak shaving from result energy labing.we suppose F grade replace by E grade that it is possible

CONCLUSION:

The objective of labeling the reduction of electrical energy consumption is particularly aimed at peak hours. It is forecasted that the plan of energy consumption label will encourage customers to buy products with higher output. If half of the buyers, pay attention to the lamp energy consumption label, and use a lamp with a same rank, we will have 700 Megawatt reductions at the load peak annually. This is in addition to the replacement of the low consumption fluorescent lamps with the incandescent lamps which has a considerable effect on the electrical energy consumption and peak load.

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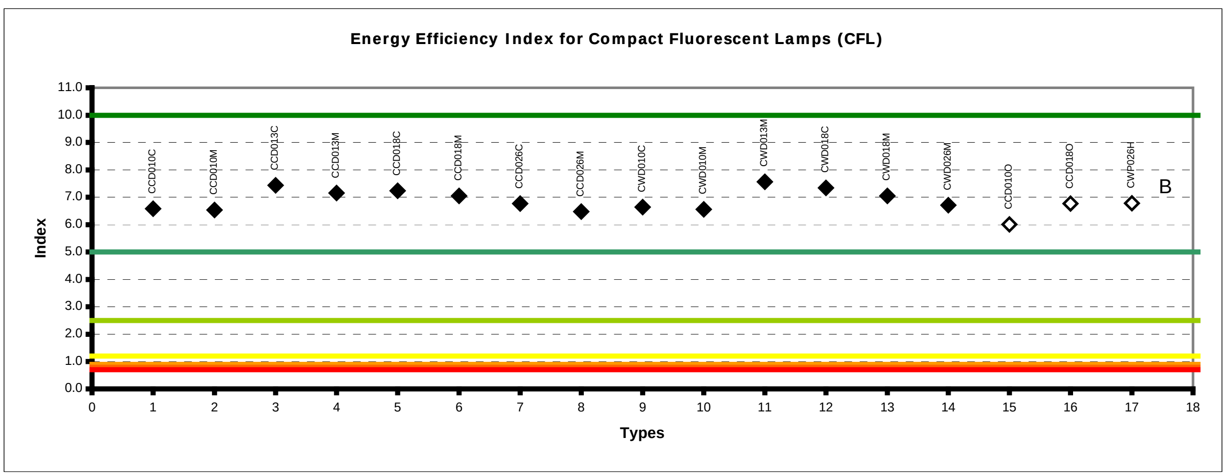

Figure (3) Indexes extracted from the tests on Compact Fluorescent Lamps (CFL)

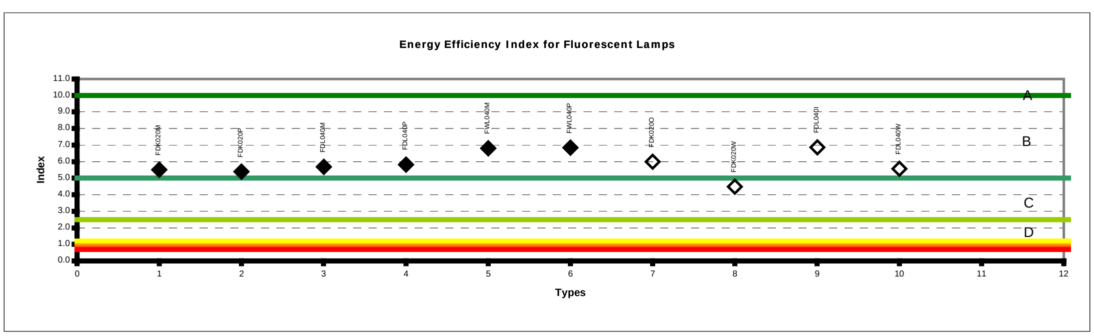

Figure (4) Indexes extracted from the tests on Fluorescent Lamps

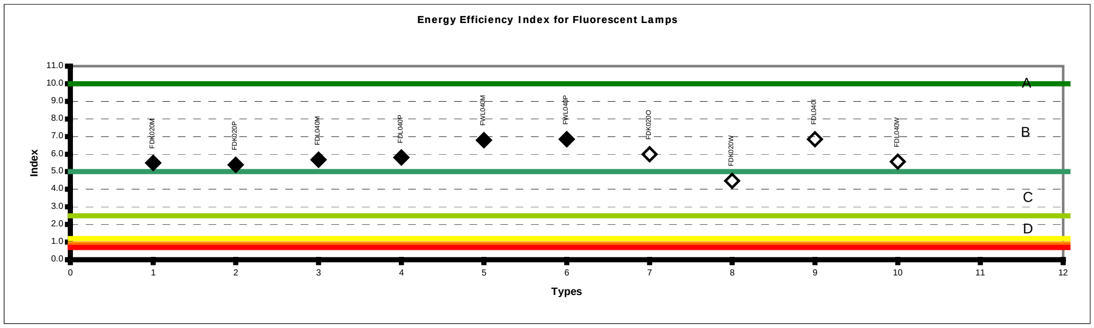

Figure (5) Indexes extracted from the tests on Incandescent lamps