

# A New Policy in Public Lighting of Cluj-Napoca

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## ABSTRACT

Cluj-Napoca is an over 2000 years old city in North-Western Romania, rich of historical and architectural monuments. With its 500,000 inhabitants, it is the fifth largest city in our country. Since 1906 the lighting network of the city of Cluj has operated from the electric distribution system. At the end of 1950s, following the application of discharge lamps, the evolution became noteworthy. Unfortunately, before 1989, due to the extremely wrong policy of the former communist government, the theoretical required illumination levels were only a third of what was recommended by European standards; the real illumination levels were even worse. Today, a great deal of effort is made to refurbish the public lighting networks of the city.

The paper presents the historical stages of public lighting in Cluj-Napoca, a proposed project for the enhancement of lighting system and the efforts related to its accomplishment. Measurements done proved good photometric and economical results; energy quality aspects of the electric network concerned with unbalanced and harmonic distortions on distribution system have to be managed in the future.

## INTRODUCTION

A good public lighting network is a vital attribute of a modern city. A proper lighting is necessary because of life safety, public protection, property security, and, the least but not the last, people's comfort. All these are associated to the necessity of pointing out the aged appearance of an old city, its richness on historical sites and architectural monuments. Thus, the development of well-designed lighting for streets and squares is an important task for lighting experts.

The electric lighting began in 1906, when the city was supplied by the hydroelectric power station at Somesul Rece, a neighbor mountain village. The development of the public lighting system was determined by the city expansion and the evolution of light sources, luminaries and lighting technologies.

The public lighting of the Romanian cities has reflected the social and economic evolution of our society. Several cities became among first in Europe to introduce gas lamps. The quality of Romanian public lighting had been similar to that of the most European countries until twenty years ago. Then, the lighting system was one of the victims of the system and energy crisis.

## THE FIRST STEPS OF PUBLIC LIGHTING

The 19-th century marked the first action in the public lighting field. Then, in 1827, 247 oil lamps were installed, and, in 1871, the gas lighting system was introduced. The 20-th century brought the interest for the electrical energy as a power source for the public lighting. On July 15, 1906 the hydroelectric power plant at Somesul Rece started the service. The city was supplied by an electric line - 15 kV, 42 Hz and 28.2 km length. An electric public lighting system using 900 incandescent lamps (luminous intensity 16 cd, voltage supply 150 V) was introduced. An expansion of the power plant allowed the growth of the public lighting network with additional 500 incandescent lamps in 1909. The continuous development of the city required a permanently extension of the public lighting network, accurately reflected in the electric energy consumption reports for the period of 1914-1916. Nevertheless, a reduction of the consumption in the period of the first World

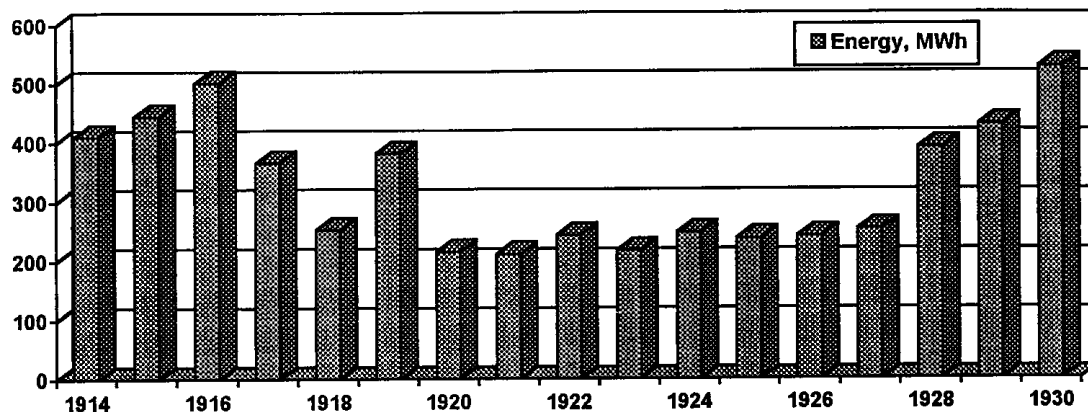


Figure 1

Table 1. Characteristics of High Pressure Mercury lamps

| Characteristics/Type | LVM80 | LVM125 | LVM250 | LVM400 |
|----------------------|-------|--------|--------|--------|
| Rated power, W       | 80    | 150    | 250    | 400    |
| Luminous flux, lm    | 3100  | 6000   | 13000  | 22000  |
| Life, h              | 24000 |        |        |        |

Table 2. Characteristics of High Pressure Sodium lamps

| Characteristics/Type | LPN70   | LPN150 | LPN250 | LPNT250 | LPN400  | LPNT400 |
|----------------------|---------|--------|--------|---------|---------|---------|
| Rated power, W       | 80      | 150    | 250    | 250     | 400     | 400     |
| Luminous flux, lm    | 5500    | 15000  | 26000  | 27500   | 46000   | 48500   |
| Envelope             | diffuse |        | clear  |         | diffuse | clear   |
| Life, h              | 12000   |        |        |         |         |         |

War may be noted. This tendency was also present in the 1920s, due to the discrepancy between the electric power demand and production (Fig. 1).

In order to satisfy the increased demand of electric power, a new power station was built nearby Cluj in 1931. It allowed the change of the old distribution system with three wires, 3x150 V, 42 Hz, to a modern one, with four wires, 3x380/220 V, 50 Hz. The lighting system was outfitted with a high frequency carrier current control system which had:

- to switch the entire public lighting network on in the evening;
- to switch half of network's lamps off at midnight and the rest at 5 a.m.;
- to supply a high frequency fire and aircraft alarm system.

#### THE MODERN AGE OF ELECTRIC PUBLIC LIGHTING

For Cluj, the modern age of electric public lighting has started after the second World War, when it was extended over the whole urban area, using incandescent lamps. Later, in 1961, the fluorescent lamps were introduced and they gradually replaced the tungsten filament lamps. The fluorescent lamps brought significant lighting engineering development in that time, by their better photometric and physical characteristics.

The 1970s witnessed a substantial and fast spreading of the High Pressure Mercury (HPM) lamps. With their

improved luminous efficacy and life, not significantly affected by the ambient temperature, they have been very suitable for public lighting.

Unfortunately, after the 1980 the Romanian public lighting was the victim of the system crisis as it was considered unnecessary under electric energy shortage conditions, related with the Gulf petroleum crisis. The same happened in Cluj-Napoca where only one lamp worked in 4-6 luminaires of the central area and only one lamp in 10-14 luminaires on suburbs; the electric light was even eliminated in some peripheral streets.

The last ten years brought the most significant changes in the public lighting history of Cluj-Napoca. The first High Pressure Sodium (HPS) lamps were installed in the city central square and on the main (East-West) city axis, in 1987. An extensive change of old low efficiency lamps with new ones from the latest generation is a recent and special focus of the local authority.

#### MODERN LIGHTING SOURCES MANUFACTURED IN ROMANIA

Because of their low efficiency or sensitivity to cold weather, neither incandescent nor fluorescent lamps are nowadays used. As a result, the street lighting luminaires are usually fitted up with discharge lamps manufactured in Romania. HPM lamps are widespread, but the HPS lamps ratio has increased in the last years. Some characteristics of these lamps are shown in Tables 1 and 2. Indeed, it was proved that sodium lamps associated with appropriate optics may provide three times higher efficiency than the former luminaires housing mercury lamps. Furthermore, HPS lamps provide the best visibility under adverse weather conditions (fog, dust, rainfall) and are reliable at low and high temperatures (-25 °C to +40 °C) frequently occurring in Romania.

#### STANDARDS

Although before 1989 the illuminance levels required by lighting standards were lower than in other European countries, the design and maintenance rules imposed by the communist government further reduced the practical values. Right after the demolition of the Eastern darkness, the existing Romanian standards have not been enforced and a strong trend to harmonize the national norms with UE regulation has become manifest. As a result, adequate

specifications for exterior lighting systems came out in 1993 and the new code of public lighting is scheduled for publication later this year.

The quality aspects concerned with the symmetry and harmonic emission limits on distribution system were regulated in 1994, in according with the CEI 1000-3-2/90 and ANSI/IEEE-519/1992 standards.

#### THE NEW POLICY IN PUBLIC LIGHTING IN CLUJ-NAPOCA

After 1990, all limitations were removed and we have witnessed a strong demand from the inhabitants for improving the exterior lighting; the electric consumption in households and public lighting has grown from 5.1% in 1989 up to 14% in 1995 and the trend continues.

The city authorities and the local branch of the Romanian electrical supplier (RENEL - FRE Cluj) determined to develop a public lighting strategy according to the international standards. For this purpose, the first step was to rehabilitate the existing network by setting up new lamps in all luminaires and by replacing the old HPM units by new HPS units on the central area and main streets with heavy traffic (Fig. 2).

In 1994, the public lighting network had a length of 692 km (410 km aerial and 252 km underground cable); 15,500 light sources from which 1050 incandescent lamps, 7400 HPM lamps and 7050 HPS lamps; 3.240 MW installed power. The on/off control is centralized, based on photo-electric devices; 9 loops with a total length of 116 km (aerial and underground cable) control 110 connection points.

As a second step, a Pilot Project for Public Lighting Improvement was worked-out by RENEL-FRE Cluj; accepted by the Electric Company Boston Edison, it was proposed for financing to the International Agency for Keeping Energy. The main objectives of the project are to bring the public lighting up to the international standards by using energy-efficient lamps and luminaires and to implement the DSM concept by using modern lighting control systems.

Under the frame of the project, two types of lighting systems were analyzed: with domestic luminaires and lamps and, respectively, with energy-efficient luminaires and HPS lamps. The study proves that the increased reliability and the reduced consumption assure a reasonable payback of the initial investments involved by a high technology equipment (luminaires and lamps) and an adequate control system.

To verify the feasibility of the project, two years ago FRE Cluj rehabilitated two main streets in the lighting class M1 (high intensity traffic road, inside the city), on a length of 2.6 km. The lighting was designed for an average luminance of  $2 \text{ cd/m}^2$ , and the luminaires manufacturers' software was applied. Thus, 43 luminaires Z2N/250T/PM (Schreder), equipped with LU 250T (Tungsramp) lamps were installed on the first street. The measured luminance was around  $1.9 \text{ cd/m}^2$  (Fig. 3). 53 luminaires SGS 102/150T and 44 luminaires SCS 306/250T equipped with SON-T PLUS 250 lamps (Philips) were installed on the second street. The measured luminance was around  $2 \text{ cd/m}^2$  (Fig. 4).



Figure 2



Figure 3



Figure 4

A survey highlights the following:

- the decrease of energy consumption with 121 MWh/year;
- the increase of luminance for the same number of luminaires;
- the reduction of the maintenance expenses;
- the payback related to the supplementary investments or high technology equipment has a low rate of 1.26 years, due to the energy savings feature.

Electric measurements concerned with the power quality aspects were done later. The Fourier analysis denoted a voltage distortion in the limits, and a current harmonic pollution larger than admitted by standard. The current harmonic factor is 1.40 to 1.90 times larger, and the harmonic levels of the third and fifth harmonic currents are 1.20 to 2.75 times larger than the IEEE-519 maximum values. The three phase network has an asymmetrical lighting load, noticeable on both fifth harmonic current and voltage.

The passive and active measures available in a public lighting network regards to the unfavorable influences due to harmonic pollution were analyzed by San Martin et al. 1997. The further actions have to be managed to reduce the negative impact of the harmonic currents on the network power losses and on the well-working of the other customers connected with the polluted public network.

#### CONCLUSIONS

Cluj-Napoca, an old city in the heart of Transylvania, is looking forward to taking its European place in the end of this century. The well-designed lighting of its area is one of a modern city's features, of its inhabitants' life. The local authorities have developed the rehabilitation of the entire public lighting. A survey of the luminous and electric components of the first actions proved that good results were obtained under the photometric and economical aspects; a current harmonic pollution has to be corrected on the electric distribution network.

Over a few years the greatest part of the public lighting will join the European standards, the city will have a new look, the energy will be more efficiently used, the people will enjoy to walk around and will live more safely. ●

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