

# **Energy efficient architectural lighting in promoting cultural heritage in Bosnia and Herzegovina**

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## **ABSTRACT**

Consequently, sustainable and ecological growth is sought to make the city more pleasant to live in and find the harmony between architecture, the street grid, open spaces, cleanliness and environmental quality. *Therefore, identity, personality, cultural and historical heritage, energy efficient living and environmental quality are the most important issues for our rapidly changing cities.* The outlook for the global economy continues to deteriorate and create new environmental changes.

Implementation of the energy efficient architectural lighting by promoting cultural heritage buildings in Bosnia and Herzegovina should be a part of the principles and standards of cultural heritage protection. It is important to educate people who make decisions of the importance of promoting the cultural heritage buildings as a resource in economic development.

## **Case study:**

*Academy of fine arts of Sarajevo, cultural heritage building*

## **Key words:**

cultural heritage promotion, energy efficiency, architectural lighting, LED innovations, economic development.

## **Energy efficiency**

Climate change and greenhouse gases are the major environmental issues for 21 century because the rapid industrial development and economic growth and many technical processes with high energy consumption, industry, consumption of natural resources has increased and thus pollution are higher.

Energy efficiency plays a central role in maintaining and improving the living stanadard.

Energy efficiency is not an alternative to energy security, but is an essential component of achieving security. The European Union currently imports 50% of its energy, and the assumption that imports will grow to 70% in the next two decades, if not take some steps. Economic stability of the European Union will depend on economic and political strategies of energy producers.

By signing the Kyoto Protocol, the European Union has pledged to reduce emissions of greenhouse gases in the countries of Europe until the year of 2020. The EU wants to cut emissions by 20% compared to the level of emissions in 1990. and to increase energy efficiency by 20% and to increase utilization of renewable energy sources by 20%. Two major European directives relating to these issues are: energy performance of buildings directive (2002/91/EC) and Directive of the efficient use of energy and energy services (2006/32/EC).

### **How to increase the efficient use of energy and make savings?**

Energy efficiency means drawing as much power as possible from every volt of electricity. To work all machines need energy. However, modern technologies allow more efficient use of energy, which means that the machine can perform the same tasks but with less energy. This is the essence of energy efficiency, and it can save significant funds.

The problem with energy-efficient appliances is that they cost more money. It is also the main reason why most customers don't want to invest. Only smart people realize that such a device long term saves money. For example in solving problems of the energy efficient illumination, fluorescent light bulb costs 4 - 7 EUR per piece, but use up to 80% less energy to achieve the same level of brightness - this ultimately brings a saving of 23 Euro per bulb comparing incandescent lamp.

### **Energetic status of BiH**

Bosnia and Herzegovina (BiH) following the breakup of Yugoslavia (1992.) is experiencing major economic and political change. According to the current structure Bosnia and Herzegovina is decentralized and consists of two entities and the district: the Federation of Bosnia and Herzegovina, Serbian Republic and the District of Brcko. The complexity of the political and organizational structure extends to the energy sector.

Energy consumption at the current intensity, accounts for 20% of her GDP of Bosnia and Herzegovina. According to the assumptions of 2000. year, household and commercial sectors account for about 50% of the total energy consumption.

The main sources of primary energy in Bosnia and Herzegovina are hydro and thermal power plants (using coal), and they cover over 62% of total primary energy consumption.

The theoretical potential of Bosnia and Herzegovina hidroelektričnoj energy is 8000 MW, while the technical potential is amount to 6800 MW and 5800 MW economically. Currently installed capacity of 2052 MW (53% of the total energy

produced) indicates the importance of hydro power in Bosnia and Herzegovina, although it is largely unused (only 37% of economic potential).

## **Energy efficient (public) lighting in Bosnia and Herzegovina**

Efficient lighting can reduce electricity consumption in lighting by 40%. In Bosnia and Herzegovina is widespread use of public lighting - and is the main cause of the loaded voltage network.

According to research by the Centre for Education and raising awareness of the need to increase energy efficiency in Bosnia and Herzegovina, there are about 7 million standard light bulbs in use. Classic lamps are very inefficient, because 80% of energy used is spent on heating energy, while only 20% of the lighting. Compact fluorescent lamps take advantage of all the energy for lighting and thereby they are saving 80% energy. The design of these lamps enables them to last up to 10 times longer than conventional bulbs.

Public lighting in Bosnia and Herzegovina is subsidized by local governments, and such lighting extensively uses inefficient lighting technologies such as conventional fluorescent and incandescent light, which are based on mercury emissions. By using efficient lighting technologies Bosnia and Herzegovina can save significant resources, but also act to reduce emissions of carbon dioxide.

As already known in the world a significant effect of light pollution in the environment is not to be neglected.

This approach confuses the cause and its result, however. Pollution is the adding-of/added light itself, in analogy to added sound, carbon dioxide, etc. Adverse consequences are multiple; some of them may be not known yet. Scientific definitions thus include the following:

- Alteration of natural light levels in the outdoor environment owing to artificial light sources
- Light pollution is the alteration of light levels in the outdoor environment (from those present naturally) due to man-made sources of light. Indoor light pollution is such alteration of light levels in the indoor environment due to sources of light, which compromises human health.
- Light pollution is the introduction by humans, directly or indirectly, of artificial light into the environment.

The ruling structure in Bosnia and Herzegovina does not have enough political will for effective decision making. There is not enough desire to take responsibility for energy efficiency within the different levels of government. In addition the authorities have very little knowledge about the management of energy resources. As a result of the economic crisis in Bosnia and Herzegovina appears to reduce the budget, and in such a situation nobody has possibility to take care about the efficient use of energy. This is just one reason why it is necessary to raise awareness about energy efficiency.

Preliminary investigations show that the costs of public lighting in the medium-sized municipalities have 2% - 5% share in the budget, and the total energy costs are between 5% and 9% of the budget on an annual basis. Although many municipalities have a problem with the closure of the budget structure, significant initiatives are not present in the field of energy savings.

### **Energy management in architectural lighting of cultural heritage**

In Bosnia and Herzegovina gradually through the reconstruction of the cultural historical heritage, there are promoted, designed and implemented energy efficiency measures and sustainable development parametres in various aspects including the lighting design, use of materials, construction.

What is important to emphasize is that engineers need to take care that the original appearance of the building must not be impaired by the use of lighting if it sets in the exterior, especially on the facades of buildings, in order to maintain the cultural and historical value.

*However, the challenge remains to harmonise interests and requirements of experts in the cultural heritage protection with a demand for an increase in energy efficiency, i.e. a reduction in cost of maintaining cultural heritage buildings and the influence on environment.*

Technology development of energy efficient lighting fixtures are in rapid growth in the last decade - LED (light emitting diode).

In Bosnia and Herzegovina there are a lot of cultural heritage buildings, areas. In the process of reconstruction, promotion of these historical values, experts need to educate investors how to use LED technology in illumination. In most cases, institutions that take care of cultural and historic buildings are the municipalities, cities, cantons. The objectives of experts and a group of people dealing with energy efficiency in the protection and promotion of cultural and historical heritage are:

- raising awareness about contemporary technologies of illuminating cultural heritage;
- education on efficient maintenance of new lighting fixtures used in cultural heritage buildings
- lighting design as a part of cultural heritage management;
- energy efficient illumination as promotion of cultural heritage protection as a resource in economic development;
- planning for future restoration and illumination of cultural heritage buildings, urban sections and old city centres.

## **Environment and LED technology**

LED (Light Emitting Diode) technology is in a very strong growth and is seen by all as the 'lighting of the future'. Currently, LED technology is used in systems, traffic signals, automotive, backlighting for TVs and monitors, camera phone as well as numerous applications for accent and decorative lighting, both internal and external. However, if LED brings improvement in terms of sustainability? First, we compare LED sources to sources with the filament, and therefore incandescent halogen bulb, which most commonly encountered in applications in accent and decorative lighting.

LEDs have a longer lifespan - lasting up to 50 times longer than incandescent bulbs. Also, LEDs are not subject to sudden blow. They also do not cease to function, they gradually fall off the performance during the lifetime, therefore, extremely highly reliable. For example, the Luxeon LED sources is envisaged that after 50000 hours of work give 70% of the initial luminous flux. LEDs were also better in terms of energy efficiency (the current 65 lm / W - however, it is constantly improving thanks to continuous investment in technology), weight and packaging (due to compact design).

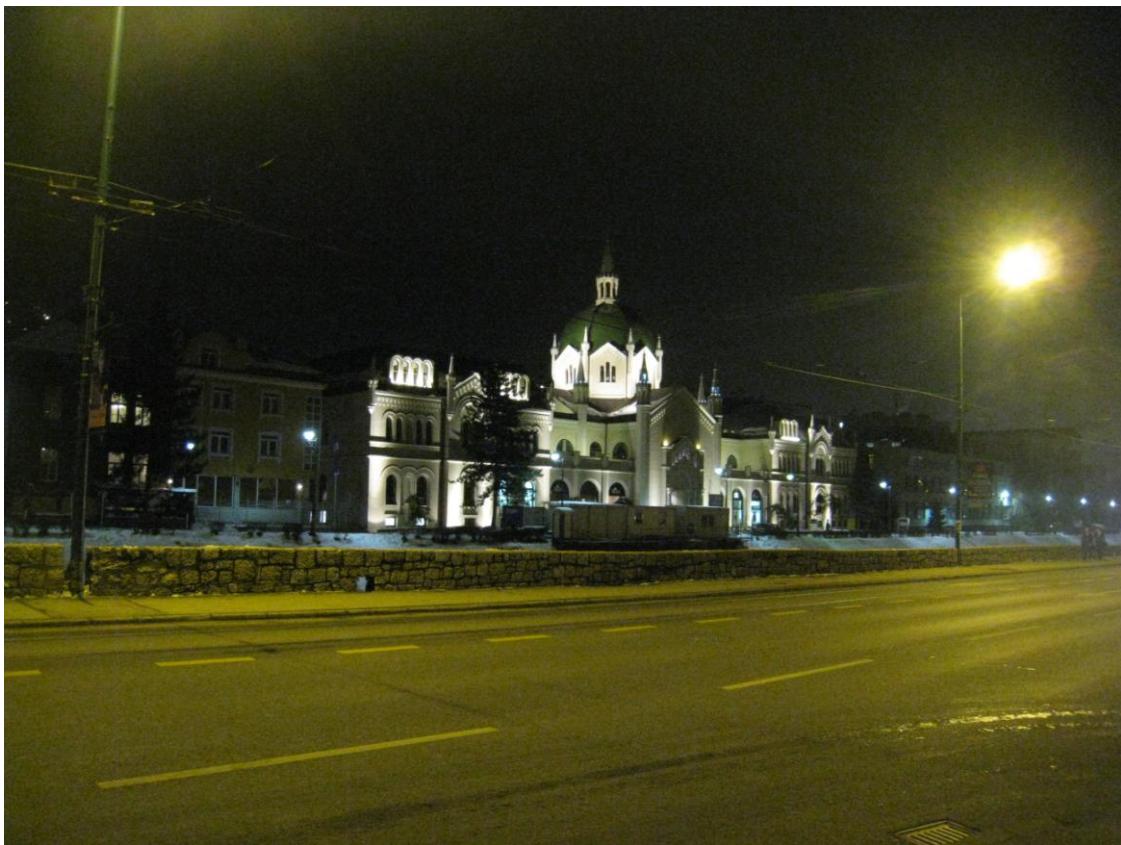
In short, the LED sources are vastly better solution compared to incandescent lamps and an optimal choice for accent and decorative lighting. Compared with fluorescent lamps and the discharge (HID), LED sources are better in terms of reliability over the lifetime, long lifetime, hazardous substances, packaging and weight.

Due to the small size, LED sources thus enabling savings in the utilization of raw materials needed for production. LED sources, as efficiency is concerned, have not yet reached the level of fluorescent and HID sources as well as fluorescent and HID, however, they are constantly working and it is expected that they will in the very near future comparable or even superior in this regard.

Therefore, the LED sources at this time less advisable in the ecological sense, as compared to fluorescent and HID sources, and because of less efficiency, which account for 95% of the total environmental impact. However, social sustainability, LED technology has some advantages such as increased security, since there are no moving parts, also there is no possibility of breakage, but also there is no possibility of exposure to toxic gases. Thus, there is nothing to break, burst, leak or contaminate.

## **Examples of projects implemented in Bosnia and Herzegovina**

In Bosnia and Herzegovina certain authorities have shown interest in energy efficient projects in the field of illumination cultural and historical heritage. On some examples we can see the successful implementation of energy-efficient protection and promotion of heritage by the team of experts; the Institute for the Protection of Cultural and Historical Heritage of Canton Sarajevo, Canton Sarajevo, Department of Building and Development of the Canton Sarajevo, City of Sarajevo.



**Picture 1: Academy of fine arts in Sarajevo**

**Budget cost of the external illumination during the night:**

Case 1: with mixed use of incandescent and LED lighting lamps (20% LED)

$$6,5 \text{ kWh} \times 12\text{h} = 78 \text{ kWh}$$

$$1 \text{ kWh} = 0,16 \text{ KM}$$

$$\text{Daily costs} = 12,48 \text{ KM}$$

$$\text{Monthly costs} = 374,40 \text{ KM}$$

$$\text{Costs per year} = 4492,80 \text{ KM}$$

Case 2: with use of only LED lighting lamps

$$1,3 \text{ kWh} \times 12\text{h} = 15,60 \text{ kWh}$$

$$1 \text{ kWh} = 0,16 \text{ KM}$$

$$\text{Daily costs} = 2,50 \text{ KM}$$

$$\text{Monthly costs} = 75 \text{ KM}$$

$$\text{Costs per year} = 900 \text{ KM}$$

We can conclude that only by illuminating the external of the building completely with LED lamps we can spend five times less energy than with 20% of LED lamps. But the case with this project was that this was the start of using LED lighting systems in projects of illumination of cultural historical heritage in collaboration with local authorities. That's why this is a positive example and a good one for the future projects.



**Picture 2: Illumination of old town Baščaršija**

City of Sarajevo and the Municipality of Stari Grad together realize the project of illumination of the street Kazazi within the illumination project of old town of Sarajevo- Baščaršija. The total value of the works is 238 000 KM.

Visually, the arrangement of this site will contribute to the rehabilitation of office space in Kazaz, which included a reconstruction of roofs, eaves, gutters and building facades in the street Kazazi. Kazazi street lighting is also based on the use of decorative LED lighting that is unobtrusive, environmentally friendly and cost-effective long-term.

The Mayor believes that the realization of the project lighting Kazaz, City of Sarajevo continues with ordering the most representative part of the old town - Baščaršije, to make it more attractive and appealing environment that will be visited more and longer by its citizens, visitors and tourists.

Bosnia and Herzegovina has launched a strategy and programs of energy savings at the state level, which will include standards for energy efficiency, energy demand management, advisory services in the field of energy efficiency, energy audits. The strategy should try to follow the EU directives on energy-efficient use of energy and energy services. Full implementation of the project would contribute to better sustainable development and its economy. It would also be a beginning of adaptation to the standards, which are already applied in the EU.

So the journey of a thousand miles begins with the first step, so that it is never too late especially to start saving energy and act for the purpose of energy for sustainable development in the promotion of cultural and historical heritage!

### **Illumination of the bridges which are cultural historic heritage**

This project was also supported by City of Sarajevo. It is the same idea that the City of Sarajevo recognized that promotion of our cultural heritage treasure is very important for the city economic development. They should be a positive example to

all other authorities in Bosnia and Herzegovina especially because in all these projects LED lighting is used!



**Picture 3: Šeher-ćehajina bridge in the old town of Sarajevo**

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