RJBS
Romanian Journal of Building Services
Revista Română de Instalații
Volume 1 / No. 3 / 2015 / www.rjbs.ro

Energy Efficiency Lighting - Romania

Dorin BEU – Technical University of Cluj-Napoca
Email: beu@mail.utcluj.ro

Calin CIUGUDEANU – Technical University of Cluj-Napoca
Email: calin.ciugudeanu@insta.utcluj.ro

Abstract: *The paper presents the Romanian experience, which is unique in promoting green buildings and the impact for lighting. Without prior experience, situation has changed with the new Romanian Green Building Council, founded in 2008, which started with courses on sustainability (including 8 hours course on lighting), with green building contest and ending with a European web-platform Construction21.eu. A major breakthrough was a 2012 Cluj-Napoca city council decision that a certified green building should receive a 50% local tax reduction. Since then all new buildings are LEED or BREEAM certified and lighting was one of the parts were buildings received a lot of points or credits.*
The sustainable lighting approach is the future oriented solution. It includes all the aspects not only technical or energy efficient ones and for this we need to rethink lighting from a broader perspective.

Key words: Sustainable lighting; Energy efficiency; Green light; LED.

1. Introduction

In 1920, around 80% of Romania population was rural and the villages had houses with vernacular architecture which we can say now that it was sustainable (re-use of existing buildings, local materials and manpower, biomass energy). Since 1950 a vast programme of building blocks of flats, based on the Soviet model, was launched all over Romanian towns and the results were the extensive use of concrete walls and the higher energy demand. Since 1990, private projects started, but without a sustainable vision; the climax was in 2007 when a lot of residential projects were finished, without connection to public transport, no interest in materials used or energy efficiency. Since the economic crisis, with the peak in Romania in 2010, there is a greater demand for green buildings. An important moment was the launch of Romanian Green Building Council – RoGBC in 2008. The Lighting Engineering Laboratory – LEL was involved in promoting sustainable lighting solutions. In 2010 the first European GBC chapter was launched – the Transylvania branch of RoGBC with Dorin Beu as president. The idea of this joint venture was to use previous experience [1] of LEL in promoting compact fluorescent lamps and to try similar approach to the holistic vision of green buildings. In fact, all the lighting topics, like Light and Health, Artificial Light At Night – ALAN, LEDs, Control Systems find their natural place in the green building concept.

The green building approach has changed the lighting paradigm, due to the holistic vision. A lighting specialist has to face to electrical lighting issues, and, also to avoid light pollution, to

optimize daylight, to integrate BMS, to calculate Light Cycle Assessment. The presence of a green building assessor in the classical triangle architect-contractor-owner has changed the face of lighting.

Lighting Engineering Laboratory - LEL [2] was involved from the beginning in green building activities as independent consultant, by information campaign, students summer courses, practice in lighting industry and case studies. The lighting refurbishment of the largest university's auditorium with LED system and dedicated control solution was a success and the starting point for a new strategy for a greener university in Romania. LEL was also involved as a consultant for the City Council of Cluj-Napoca plan to replace existing luminaires with LEDs in order to reduce CO_2 emissions.

2. RoGBC involvement

Since 2008 RoGBC was involved in several projects. The first one was the Green Building Professional, a certification and training program to provide greater certainty of the abilities of professionals working in construction and related industries toward a sustainable built environment. The program requires eight courses one being "Lighting Design & Smart Buildings" with six hours of teaching. Other projects are "Ecobiblioteca", a green building library in Cacica, one of the first in Romania to have only LED luminaires, Construction 21.eu a multi-stakeholder collaborative platform dedicated to all professionals involved in green buildings, Green Awards (Green Building Project, Sustainable Company, Green Product Innovation, Green Service Provider, Green Building Education Initiative, Government Initiative), Building Greener Schools [3].

The RoGBC Transylvania Branch had a major success with promoting a City Council law - HCL 225/May 2012. According to this decision, if a building has an A label energy efficiency certificate and a green building assessment (LEED, BREEAM or DGNB) it will be granted 50% reduction of local taxes. On May 2012 there was no green building certified in Cluj-Napoca, but now there are already seven. In 2014 it was decided that BREE in Use will not be taken into consideration, as it is too easy to be obtained and it measures only building management.

3. Lighting Energy Laboratory

Since 1999 the Lighting Engineering Laboratory – LEL plays an active role in the lighting community. Initially called the Lighting Engineering Centre [2], it was created by professor Florin POP as a centre for consultancy and continuing education in lighting field. One of the most appreciated results was the "Ingineria Iluminatului – Journal of Lighting Engineering". Today LEL continues this project, trying to find best solutions for end-users from what industry has to offer and based on last researches. In order to have a large scale involvement, the natural involvement in the green buildings with three directions: education, refurbishments projects and studies related to further lighting developments.

Education is a key aspect; on the high-end is Lighting Engineering Journal and on the base-line preparing a new generation of students. Every year three students go to OMS-Slovakia for three

months practice, other three were involved in LiDe summer schools (2013 – Athens, 2014 – Porto). Together with Students Associations, we were involved in The City of Green Buildings, an Autumn School – Cluj-Napoca 2014. As a result, four projects were submitted to build a new university laboratory area, which should be a green building.

LEL is a member of the EU Cost programme LoNNe – Loss of Night Network. LoNNE was started in 2012 and will last till 2016. His aim is to bring together researchers interested in ALAN, with its impact on humans and biodiversity and try to find solutions to reduce this impact. LEL is a partner of Romanian network to promote Dark-Sky parks and to have a new legislation for reducing light-pollution.

4. Case study – Cluj-Napoca City Hall and public lighting modernization using LED technology

Cluj-Napoca City Hall, Romania developed a new lighting rehabilitation project for the year 2014, under the frame of the Swiss-Romania cooperation programme. The project, involving 22 streets and two of the City Hall buildings, was designed by the Lighting Engineering Laboratory – Technical University of Cluj-Napoca.

The lighting system of the two City Hall buildings (19,531 sq. m) is based on 1094 luminaires using fluorescent and incandescent light. The modern luminaires using LED technology were proposed to upgrade the involved interior lighting systems. All the lighting equipment was geared with DALI protocol driver (except those for bathrooms and hallways), allowing their control in the future, using a new tele-management system. Additionally, a new command and control lighting system designed with automatic adjustment of light levels, was implemented in four offices for experimental purposes. The luminaires were equipped with presence sensors and light sensors, which take into account the natural light level and the room occupancy level. The future study and oversight of the system will highlight the opportunity of its implementation for all the City Hall rooms.

The public street lighting was largely based on sodium lamps. The lighting system was partially upgraded during 1997-2007. Today, the public lighting electric energy consumption for the 22 streets (1358 luminaires) reaches 1,096,898 KWh/year.

The modernization of public street lighting luminaires involved replacing existing luminaires using sodium lamps with modern luminaires based on LED technology which are much more energy efficient. The new luminaires were equipped with wireless communication components and electronic ballasts that allow them to function in different power levels on different time schedules.

The main objectives of the project were to reduce energy consumption, running costs and carbon dioxide emissions, preserving or even improving the existing visual comfort. By implementing this project there are expected total electricity savings of about 44% for interior lighting, and 54% for the public street lighting. The total annual energy reductions are about 762 MWh/year with a cost reduction of approximate 75,000 euro/year [4].

This predicts a reduction of annual carbon dioxide emissions by 377 t CO_2 over one year. The CO_2 emissions are calculated taking into consideration the total energy savings and the average value of 494.660 g CO_2/kWh for Romania [5], the year 2012 that was provided by the Romanian Electrical Energy Company – ELECTRICA S.A., Table 1.

	Installed power reduction [kW]	Power consumption savings [MWh/year]	Carbon dioxide emissions reduction [tCO_2/year]
Indoor lighting	43.37	169.70	84
Outdoor lighting	162.32	592.47	293
TOTAL	205.69	762.17	377

Table 1. The estimated project savings

5. Case study – T8 4*18W fluorescent luminaires refurbishment using LED

As the main lighting source presently used in many Romanian administrative and educational buildings is T8 4*18W fluorescent luminaires, LEL analysed a new refurbishment lighting solution A new LED refurbishment solution was adopted using 4 LED 14.4 W strips and two LED drivers Xitanium 36 W for replacing the old fluorescent lamps and the conventional electromagnetic ballasts, keeping the same old luminaires shell and reflector. The drivers used have the possibility to adapt the LED luminous flux by using different added resistances. This was a very important issue because of the one to one desired refurbishment solution with practically no impact on the constructions (there is no new wiring needed). So the luminous flux of the luminaires could be adapted for the different room destination requirements.

For instance, for the hallways no additional resistance was added - initial electricity consumption for the T8 4*18W, of about 89W was reduced by more than 75% to a value of 21W. According to SR EN 12646-1:2011 – 5.36 Educational Buildings [6], hallways and circulation areas, the requested average illumination level is 100 lx and 0.40 uniformity. Bought lighting systems are close to the required average illumination level – Table 2. The LED system has a better uniformity value and uses only 25% electric power.

MEASURED RESULTS	T8 4*18W	LED 4*14W
Minimum ilumination level [lx]	72	66
Maximum ilumination level [lx]	181	140
Average ilumination level [lx]	110	95
Uniformity	0.65	0.70

Table 2. Measurement results

Three different value resistances were added to the Xitanium 36 W 0.12-0.40A. Table 3 presents the measured consumption and power factor of the one LED 14.4 W strip, powered by one 36 W Xitanium driver.

Resistance [ohms]	Power consumption [W]	Power factor
0	5.8	0.77
330	9.2	0.86
470	11.8	0.89
680	15.6	0.92

Table 3. Measured values 14.4 W LED, Xitanium 36 W driver with different value resistance added

6. Discussions

With the new LEDs we get use to easy dimming, change in color, or, lately, change in correlated colour temperature. So what‘s next? We have to solve the problem of lighting installations over sizing. For instance, for an interior lighting installations, instead of achieving 500 lx, designers may obtain a maintained average illuminance 550 lx (an extra 10%) with a maintenance factor of 0.8 (which is optimistic) will lead to 687 lx, which is an over sizing of 37%. Taking in consideration that in many cases due to the use of the same luminaire in all rooms the maintained average illuminance is even bigger and in some case designers goes with a maintenance factor of 0.56 (taking in consideration all factors) it may result in a electrical power multiplied by two in the initial stage. In the case of street lighting, you take the worst case scenario (the place where street is wider, and then you use the same luminaire all over). So soon it will be important that all luminaires to have constant luminous to obtain the illuminance/luminance level required by norms, in order to avoid bigger initial power consumption. The next step will be adapting the luminaire photometry to room/street. Now we try to obtain the minimum number of a specified luminaire that will exceed norm specifications. In future, we will obtain the optimized photometry and luminous flux/luminaire that will comply 100% with norm specifications.

It is not easy to change luminaire photometry now, but in future it may be easier than we expect. There are two options:

1. Mechanical changes: on site you change the lenses, add remove LEDs. Based on computer calculation that will optimize every luminaire, you will have to adapt them by contractor/distributor.

2. Digital changes: luminaires will be installed and then through the bus to modify the photometry. This is like with the moving-head projectors.

There are endless possibilities than to adapt the distribution of luminaires to the real situation. In interior lighting, you can easy adapt to an office layout change (500 lx on the desk and 300lx near them). In the case of exterior lighting, lighting installations can adapt easily to traffic flow changes, snow/rain situation, vegetation changes etc.

Till the economic crisis, brand and design were extremelly important. As the technology changes, we hear about new brands all time and the hierarchy is not very clear anymore; a little bit like in mobile phone industry. With new LED components for OEM you can start producing LED luminaires everywhere. For some companies, design was a way to differentiate and to innovate; some luminaires where design icons. Now it is very hard to tell who is the producer of a down light or of a spotlight. The so called unobtrusive lighting doesn't allow too much design. Rapid prototyping is the blessing/curse of the industry; in one hand you can produce prototypes quick but you can also copy success luminaires. Most of the producers are only converting old fluorescent luminaires to LED and few try to rethink the luminaire. On the other hand the developers are interested only by cost, and buy no-name products in containers. Everyone is proposing five years warranty and no one talks about fault rate. There are only rumours about fault drivers and other problems in the luminaires, but no papers with data.

One of the big advantages of major companies are the specialists working for them; they know the standards, know the architects and have networks. But in a market with few new projects and price-oriented developers they cannot make miracles and that's why many are oriented in retrofitting existing buildings. Some companies try to turn into ESCOs, others talks about leasing luminaires.

On the other hand, electronic companies have moved into lighting; with product with energy efficiency, but with quality issues (uniformity etc.)The design is basic; luminaires are huge radiators with industrial look, but at the end it gives light (standards demands are still an issue).

Many companies have gone in the so called media-facade lighting. At first glance it looks impressive, but then one can realize this is not lighting but advertising. Technically you need RGB LED with IP 65 and the possibility to control it with Video Control Unit. Obviously this is not a green solution as we are talking about something which is not necessary for ease to view, safety or comfort of people. A few years ago we were discussing about RGB luminaires, a technical achievement, but a useless one. I know the argument that we are in a world that is obsessed by images but the idea that we won't see soon architecture, but images seems like an oxymoron.

There was a working group WG 11, who tried to make a new European standard regarding daylight. If they would succeed doing, there will be a major breakout because it means that they manage to give an evaluation of a good daylight interior and that is accepted from North to South. For the moment it is in standby. It is not very clear who will be in charge with daylight studies: architects or engineers and if we have enough specialists for this topic. The pressure from green issues is high and there are major differences from LEED to BREEAM. Daylight is

essential for getting low LENI values, but no one ask the lighting designer about windows dimensions, orientation and view out. There is much to do in this direction.

In the years to come a lot of research will be in the area of electrochromic windows. A major problem of any window is the glare and many of them are blocked with blinds; the possibility to change the transmittance according to sunlight is very appealing with a reasonable price.

7. Conclusion

There was a working group WG 11, who tried to make a new European standard regarding daylight. If they would succeed doing, there will be a major breakout because it means that they manage to give an evaluation of a good daylight interior and that is accepted from North to South. For the moment it is in standby. It is not very clear who will be in charge with daylight studies: architects or engineers and if we have enough specialists for this topic. The pressure from green issues is high and there are major differences from LEED to BREEAM. Daylight is essential for getting low LENI values, but no one ask the lighting designer about windows dimensions, orientation and view out. There is much to do in this direction.

In the years to come a lot of research will be in the area of electrochromic windows. A major problem of any window is the glare and many of them are blocked with blinds; the possibility to change the transmittance according to sunlight is very appealing with a reasonable price.

The lighting is moving with influences from technical, political (EU regulations) and sustainable issues. The green building approach is an excellent opportunity to promote best available lighting solutions and sustainable lighting. There are a lot of new opportunities and challenges, but also errors that can be avoided through information exchange, and this is the main role of conferences like EENVIRO 2015.

8. References

[1] EnERLIn - European Research Project - EnERLIn Energy Efficiency Lighting Initiative (EIE-05-017); 2007.
[2] Pop, F., Ramon, S. - Lighting Engineering Centre - LEC - consulting and continuous formation. Tempus Phare CMS - Compact Measures; 1999.
[3] Beu, D. - Lighting - what will change in the years to come. Balkanlight 2012 - Beograd, p. 293 – 297.
[4] Beu, D., Ciugudeanu, C. - Lighting – Between Nostalgia and Extreme Anticipation. BulLIGHT 2014 International Conference; Sozopol; Bulgaria; 10-13 June 2014.
[5] LEL - Lighting Engineering Laboratory UTC-N. The Modernization and Expansion of the Public Lighting System and Upgrading Lighting System in Two City Hall Buildings Using LED Technology. Project nr.380333/2013; Cluj-Napoca.
[6] SR EN 12464 -1:2011 - Light and lighting - Lighting of work places - Part 1: Indoor work places.