RESIDENTIAL ENERGY EFFICIENT LIGHTING, progress accomplished in the frame of EnERLIn and CREFEN projects

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Abstract

Both in European Union countries and in Romania, the residential sector represents an important potential for the reduction of energy consumption. The energy consumption in this sector is focused on lighting and domestic appliances and heating/air conditioning/hot water. The efficient use of electricity is still a neglected issue, with a lack of the necessary statistic data.

The Lighting Engineering Center of the Technical University of Cluj-Napoca (LEC UTC-N), Romania was involved in two programs for promoting lighting energy efficiency and energy saving measures in residential buildings: ***EnERLIn*** *- European efficient residential lighting initiative, an EIE - SAVE program to promote Compact Fluorescent Lamps (CFL) in the residential sector, and* ***CREFEN*** *– Integrated software system for energy efficiency and saving in residential sector, a Romanian CEEX program.*

The EnERLIn consortium work was focussed on the better promotion of Compact Fluorescent Lamps (CFL) for residential use. The main outputs from the project is the creation of new European CFL-Quality Charter, the design of attractive CFL promotional campaigns, the creation of CFL quality criteria and comprehensive databases.

The CREFEN project achieved an integrated software system for reducing the energy consumption and promoting an advanced energy management in residential buildings in Romania. The software applications are focused on the electric energy efficient use and saving in residential sector.

1. EnERLIn - European Efficient Residential Lighting Initiative, supported by IEE - Intelligent Energy Europe programme

Lessons learnt during the first two years operation of EnERLIn programme

Professor Zissis, the coordinator of the EnERLIn project, considers that during the past 24 months since the starting of the project, the main lessons learned by the consortium are the following [6]:

- End-user is very regarding on CFL-Quality. Low quality devices “pollute” the market and seriously impede the increase of market penetration of that energy efficient technology. A systematic CFL-quality control is imposed in EU level following a well-defined unique testing protocol and associated with readable and compulsory labelling.
- There is a significant lack of knowledge and data on the penetration and the trends in use of various lighting technologies in households. This is especially true in Eastern European countries, therefore it is difficult to clearly articulate what we would like to achieve with a campaign and whom exactly we could target in order to increase efficient light sources penetration.

- The involvement of many different actors and coordinating with the government authorities and ministries level needs an important investment on time than expected but it is necessary. The politic attention on Climate Change have created activities in many levels in the society which have engaged the EnERLIn people in many discussions to coordinate action.
- Energy efficient lighting has become a more and more relevant topic in all sectors: private consumers, public authorities, and in enterprises. Increasing costs for energy and maintenance, environmental debates, and several EU Directives have especially increased the demand for energy saving solutions in municipalities. Also in the sector of private end-consumers, the awareness for environmental integrity and high-energy prices have lead to a rethinking in the use of energy saving lighting. The potential for the implementation of environmental friendly and cost saving lighting measurements is still very high. Initiatives such as EnERLIn play a major part in promoting such technologies and help to overcome barriers. The high number of participants in the workshop series and the high demand for advisory on the one hand and the still low number of good practice examples proves this.

New CFL quality charter

This year the European Commission, through Joint Research Centre, is preparing a new European Compact Fluorescent Lamps Quality Charter. In the introduction is mentioned that "total domestic lighting consumes about 86 TWh in the Union and it is predicted to raise to 102 TWh by 2020. Compact fluorescent light bulbs (CFLs) use at least 60% less electricity than the traditional incandescent lamps while lasting ten to twelve times as long and can therefore deliver substantial savings in terms of both electricity and money." The idea of this quality charter is to promote CFL for the remaining 95% of the residential lamp market, but with minimum quality criteria in order to increase consumer confidence. The mains modifications are related to stabilised light output (time to 80% of stabilised light output, after switch-on from cold, at normal room temperature, shall be less than 60 seconds and 30% of stabilised light output after switch-on from cold, at normal room temperature, shall be less than 2 seconds) and comparison CFL/GLS (instead of previous 1:5 ratio, a new 1:4 is indicated.

Incandescent lamps shift-out

The European Union has proposed a ban on incandescent light bulbs, planned to come into effect in the near future, but this will not affect existing incandescent bulbs, only the production of new bulbs. This proposal has to be approved by all member states or the European Parliament. Italy will ban the sale of incandescent light bulbs as of 2010. Germany's Environment Minister has urged the European Commission to ban inefficient light bulbs in the EU in the fight against global warming. The EU could reduce carbon dioxide emissions by 25 million tonnes a year if energy saving light bulbs were used in both the domestic and services sectors. Belgium's Minister of the Environment is intent to ban incandescent light bulbs, and thinks the ban on incandescent light bulbs should be included in the list of measures under the Kyoto Protocol. In Ireland, the government proposes to ban traditional incandescent light bulbs

in January 2009. On the 27 September 2007, the government in the United Kingdom announced plans to phase out the sale of incandescent light bulbs by 2011. Under the plan, retailers will voluntarily decline to stock 150 W bulbs from January 2008, 100 W bulbs from January 2009, 40 W bulbs in 2010, and all remaining bulbs by 2011. These plans are voluntarily, however they have had wide support from retailers and consumers. Though the initiative has been criticised by environmental groups such as Greenpeace, and other political parties, who believe mandatory measures should be introduced.

EnERLIn questionnaire campaign

According to the EnERLIn programme, the EnERLIn questionnaire campaigns were promoted by two subcontractors of the project and the local Electrica distribution company in seven steps, starting with November 2006 till May 2008. There were 545 answers (it means households) and 1804 CFLs used, so the average number of the CFLs is 3.31 units per household. Finally, both campaigns - CREFEN (November 2005) and EnERLIN (November 2006 - May 2008) denote on average **2.82 CFLs per household**. The CFL distribution power is presented in Figure 1.

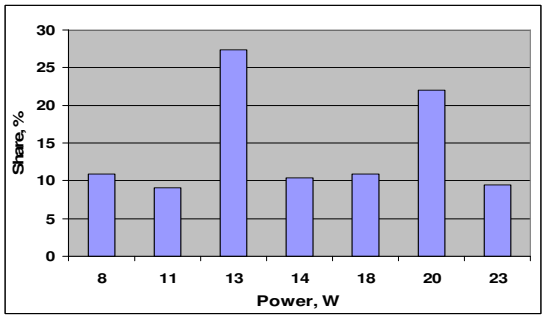

Figure 1: CFL distribution power in Romania - 545 households, 2008 – [4].

Newly updated CFL sales figures for Denmark show the CFL distribution power on 2000 Danish households - Figure 2. There are on average 9 incandescent lamps per household, **6 CFL**, and 8 halogen lamps. 16% of Danish households still do not own a CFL. [5]

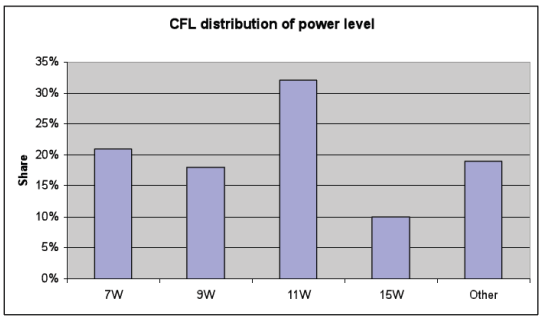

Figure 2: CFL distribution power in Denmark - 2000 households - [5].

In Bulgaria, there are on average 0,6 CFLs per households [5].

2. CREFEN – Integrated Software System for Energy Efficiency and Saving in Residential Sector

The **CREFEN 2005-2008 project** aimed: - to create an integrated software system-tool focused on the applications concerning the electric energy efficient use and saving in residential sector in Romania; - to develop the necessary databases of equipment and endowments from residential sector, using the market surveys and questionnaires; - to develop an advanced modelling and simulation software system-tool of electric energy consumption in residential sector and of economical effects; - to implement an application with databases, an interactive educational application and electronic book related to the energy efficiency use in order to influence the consumers' options in selecting energy efficient appliances for environmental protection.

The project was connected with energy efficient use according to EU directives from one side and with the implementation of database applications using web-based technologies for assisting and influencing the consumers decision in selecting the domestic and lighting appliances from the other side, that leading to sustainable environment management. The last aim of the project was for environmental protection by reducing the CO_2 emissions.

The CREFEN Integrated Information System for Energy Efficiency and Saving in Residential Sector allows:

- Access to information related to household appliances, electronic and office equipment available on the Romanian market;
- Interactive estimation of energy consumption in residential sector and of economical and environmental effects;
- Assist consumers in energy saving at homes.

The software application architecture is a modular one, with the possibility of its extension with new functionalities, without perturbing the other components or requiring the reorganization of the system data. The application runs on PC systems connected to the Internet in order to access information through a browser at http://atlas.ici.ro/crefen, Project Director Prof. dr. Adriana ALEXANDRU, E-mail: adriana@ici.ro

A CREFEN *Questionnaire campaign* was realized in order to acquire information as ownership rate for each appliance, rated power, average operation period and others (efficiency, resources consumption). The households' composition was desegregated by urban multi-apartment block, single urban dwelling and single rural dwelling. The households' distribution was made according different criteria as: geographic site, rural or urban environment, family income, dwelling size. A total of 204 questionnaires were obtained from a large geographical area. The first obtained data regards the attitude of the questioned people to the energy efficient domestic appliances topic - more than 70% agree that the decision to buy an appliance should be based on energy efficiency class as well. The consumption in the household utilities is presented in the Figure 3. The motivation of the CFLs use is presented in Figure 4.
In further works, after receiving and processing the data, the reference status of the residential electricity consumption at the level of the year 2006 will be obtained. The residential electricity demand will be estimated using the MAED model elaborated by the IEA, following development scenarios on medium and long terms.

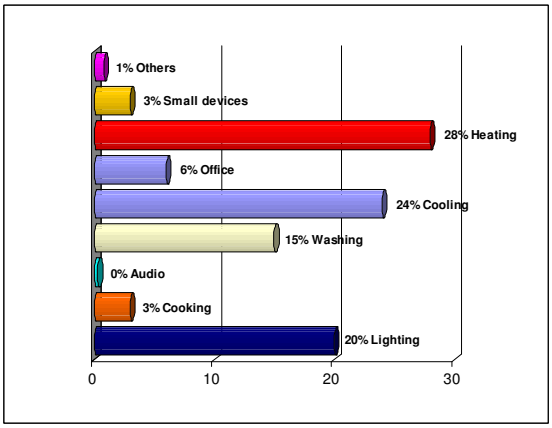

Figure 3 Consumption of household appliances

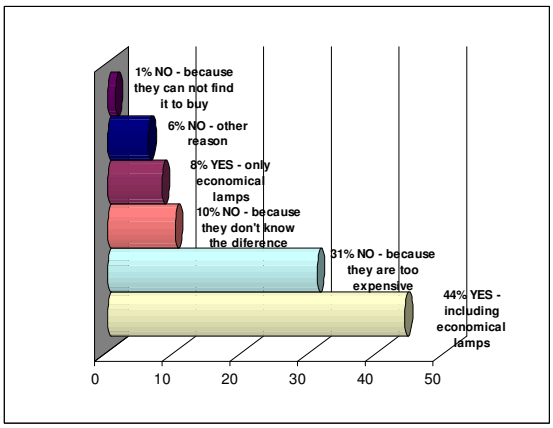

Figure 4 Motivation of the CFLs use

Electric lighting design based on minimal installed power

The design and build of an energy efficient home requires a careful planning of details. A global approach of design may help creating a success strategy towards the use energetically efficient technologies. The light quantity and quality around us denotes how well we see, work or play. The light affects our health, safety, morale, confort and productivity. By adequate design and selection of the lighting system important energy savings may be realised, while maintaining a high qualitative and quantitative illumination level. For residential buildings an initiative with high perspective for the achievement of long run energy savings is the replacement of incandescent lamps with compact fluorescent lamps.

The Romanian homes design norm NP057-02 recommends the *specific installed electric power* for homes lighting at a value of minimum **20 W/m^2** of floor surface. This value is valid for the use of incandescent lamps in rooms lighting. When realizing an energy efficient lighting system that uses CFLs for rooms lighting, the light flow emitted by these lamps is about four times larger than that from incandescent lamps. Thus, the specific installed electric power for homes lighting has to be reduced about four times, at a value of minimum **5 W/m^2** of floor surface. With these values the average illumination level on the working plane for the general illumination of the room of about 100 lx is obtained.

The design of energy efficient lighting has to consider a few basic requirements:

- more light is not necessarily a positive element; visual performances of an individual depend both on the light quantity and quality;
- selection of a lighting system appropriate to the room destination;
- use of localized lighting wherever possible and reduction of the general illumination level;
- use of modern lighting technologies and of adequate control means;
- use of natural light.

Some of the methods to obtain energy efficient interior lighting:

- installation of luminaires with fluorescent lamps for all relevant positions (ceiling or wall mounted) where a use of more than two hours daily is assumed - kitchen or living room, bathrooms, halls or bedrooms;
- use of LFC in dedicated luminaires instead of mounting them in LIG dedicated luminaires; this would encourage the use of LFC throughout the duration of existence of the building;
- use of LFC for portable luminaires with a use of more than two hours per day;

- use of luminaires with the energy label of type A - ENERGY STAR;
- use of presence sensors to open and close the light as needed;
- use of light colors for the interior walls, with the purpose of reducing the electric lighting.

A well elaborated design implies selecting one or more optimal solution for the illumination of a room, and then selecting suitable luminaires, lamps and control systems. The design offers solutions for introduction of these technologies in a room such that optimal illumination conditions are assured for regular home activities and the apparent aspect of the room is as well enriched. For a complete design we have, as well, to consider the room size and shape; architectural style and furniture; price, availability and necessary of electrical energy for all the utilities, and the necessary effort to install the luminaires. Different energy efficient lighting solutions are applicable for specific rooms of a home - the optimal choice of luminaires, lamps and lighting control systems such that optimal conditions for electric energy saving are ensured without diminishing the visual performance or even with an increase of it. These models may be adapted to almost all the conditions met in a usual home. Energy efficiency of the proposed electric lighting systems will be improved if the availability of the rooms' natural lighting is taken into account. These situations will be analyzed individually when designing new buildings or refurbishing old ones. All energy efficient lighting systems have annual working costs lower than the usual systems. We have to consider the average working characteristics of electric lighting in homes - number of working hours of a lamp, illumination setting, and occupation degree of a room. The price, life duration and power of lamps are data provided by lamps producers. Usual rooms and their lighting systems are the starting point in the evaluation of an energy efficient lighting system. The time behaviour of current lighting systems, experts opinions, examination of the usual design modalities, models of homes of owners with average and small revenues were the factors used to establish the characteristics of a classical installation and to propose energy efficient solutions.

Web application for the IT module Electric Lighting

Any person is interested to create, in his/her home, a modern, comfortable and economical environment. The proposed application aims at *the electric lighting design based on the minimal installed power*. The application is developed in a simple manner, to make it accessible to any person with minimal knowledge of information technology and with Internet access.

The realized application allows the selection of any desired type of lamp - incandescent lamp or compact fluorescent lamp, tubular or ring-shaped. When selecting the incandescent lamp for a certain room or for the whole apartment, the application uses the specific installed power of 20 W/m^2, and when selecting the fluorescent lamp, the application uses the specific installed power of 5 W/m^2. Thus, the user may design different versions of equipment sets with the aim to equip the home with different lamps, and to compare the electric energy consumption based on the data from the report - total installed power and total consumed power for a full year.

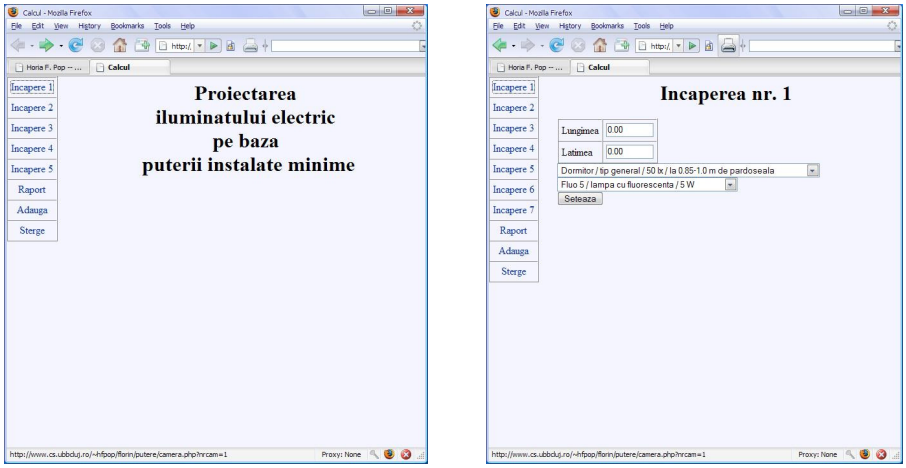

Figure 5 The opening window and one of the working windows of the application

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