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LIGHTING USE IN SERBIAN LOW-RISE HOUSES

Abstract: *This paper shows the survey in Serbia in city of Kragujevac devoted to the lighting use in Serbian low rise-houses. Related to this use, the survey examines the occupancy patterns in the houses. The survey gives the distribution of lighting throughout the house according to types of light bulbs. The survey informs us how the light-bulb use depends on the location of the house, age of the house and the income of the residents inside the house.*
Keywords: *Public opinion survey, Energy saving, Public action, Lighting*

1. INTRODUCTION

Since the global environmental crisis, energy and environmental concerns have increased in priority in building construction and operation. It is important to understand position of people with different role on energy savings in different buildings and countries during entire building life cycle. This is done by using questionnaire surveys.

By questionnaire surveys, energy efficency efforts are examined in different types of buildings such as hospitals, administration buildings, schools, universities, industry office building, hotels, departments, and residential buildings. In China, Nepal, and Scotland, energy-efficiency efforts are explored related to municipal heating in hospitals, administration buildings, schools and universities [1-2]. For industry office building in tropical zone, questionnaire survey revealed potentials for sustainable improvement in building energy efficiency [2]. Ali et al. [3] designed and distributed a survey to hotels' managers and departments' supervisors to understand the environmental performance in the tourist accommodation sector in Jordan. A telephone survey in England and Wales investigated an interest in purchasing mitigation and adaptation improvements against their concern about climate change, and attribution of responsibility for action in old residential buildings [4]. Wang et al. [5] studied the survey status of energy consumption and energy-efficiency management of new rural residential buildings in Hangzhou, China and energy efficiency awareness and willingness. Watts et al. [6] evaluated energy efficiency priorities, an awareness of the domestic energy performance certificates scheme, and recognition of its potential for homebuyers for low-rise residential houses.

By questionnaire surveys, different people were approached such as architecture students, architects, LEED accredited personal, hotel managers, department supervisors, users (homeowners) of different buildings. A

survey of the architecture students revealed their awareness on building energy efficiency technologies [7]. A survey of architects was conducted to assess their view on the barriers and incentives to implementing and sustaining energy conservation strategies in their projects [8]. A web-based anonymous survey of LEED accredited professionals revealed their awareness, and confidence in research work in the construction research of green buildings [9]. Bichard and Kazmierczak [4] investigated interest of homeowners in purchasing mitigation and adaptation improvements. Seitz et al. [10] approached the consumers to find the most desired attributes of home air-conditioning systems. Ma et al. [11] studied the resident attitudes of residents on energy-saving household appliances. Watts et al. [6] surveyed homebuyers on their energy efficiency priorities, an awareness of the domestic energy performance certificates scheme, and recognition of its potential.

This paper presents results of the examination of the home owners of low-rise residential houses in Serbia in city of Kragujevac on lighting used in their houses. The examination is done of the 165 home owners by a questionnaire survey. The survey examines awareness of the homeowners on energy savings during the lighting use. It investigates the use of energy saving light bulbs-fluorescent bulbs regarding knowledge on the energy savings, house location, type of rooms, size of the house and income of residents.

2. METHODS

This paper presents results of the 2011 survey in Serbia in city of Kragujevac on the lighting use in low energy houses. The general research approach is based on the structured questionnaire survey. The questionnaire is specially designed for this study. This is chosen because it allows a large number of subjects to be studied. The data collection technique is hand-delivered, self-administered survey. This method is chosen because it could efficiently reach a large sample, and allowed ease of response. The questionnaire is a more effective alternative to interviews because it enabled a greater proportion of the population to be reached within a limited time frame. Respondents are requested to base their responses on the home that they live in. A summary of the survey findings was available to respondents who are interested in the research to encourage participation.

Table 1. Total area of houses

Percentage of total number of houses			
<80 m^2	80-120 m^2	120-200 m^2	>200 m^2
19%	34%	36%	11%
Number of stories			
1	2	3	
38%	55%	7%	

Table 2. Age of house and net income in households

Age of house (a)		
<20 a	20-40 a	>40 a
31%	52%	17%
Net income in households (€)		
<6k	6-12k	>12k
42%	33%	21%

2.1 Participants

All printed material, including text, illustrations, The hundred and sixty people responded to the survey. Each of respondents owns and lives in a house located in the municipality of Kragujevac, Serbia. Number of residents is 660. Half of residents are male and half of them female. No control was kept over the demographic and socio-economic characteristics of participants, so consequently the sample constituted large families and people living on their own, and people in different professions and retired. The houses are almost evenly distributed between city core, suburb, and countryside. Total area

are of houses is given in Table 1. Almost half of houses have area less than 120 m^2 and rest greater than 120 m^2. Number of stories in the house is given in Table 1. The most houses have number of stories less than 3. Age of houses is given in Table 2. Most of houses are above 20 years old. Net income in households is given in Table 2. The most of residents have income below 12k €.

2.2 Presence in rooms

Figure 1 shows the survey results on how long different rooms are used. The investigated time spans are up to 5h and above 5h. The living rooms are used the highest amount of time while the all other rooms are used almost the same amount of time.

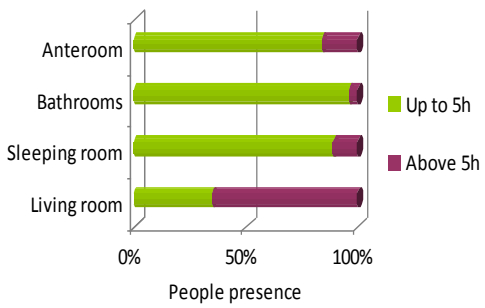

Figure 1. How long are different rooms used?

3. RESULTS & DISCUSSION

3.1 Types of used light bulbs

Figure 2a shows the results of survey on the type of light bulbs that are used in the house. Tenants use either only incandescent bulbs, or only fluorescent bulbs, or the both types of bulbs simultaneously. The survey shows that the highest number (56%) of the tenants only uses the incandescent light bulbs in their houses, while the lowest number (3%) of them use the fluorescent light bulbs only.

Figure 2a shows the results of survey on type of light bulbs that are used in different rooms of the house. The investigation shows that the fluorescent light bulbs are the most often present in living rooms that have the longest occupancy. The investigation shows that the fluorescent light bulbs have their lowest presence in the bathrooms that have the smallest occupancy.

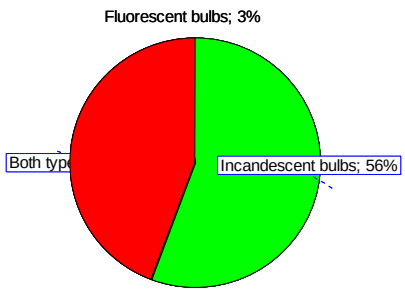

Figure 2a. Type of light bulbs used in the house

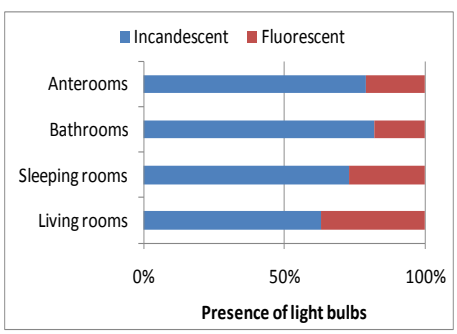

Figure 2b. Type of light bulbs used in different rooms

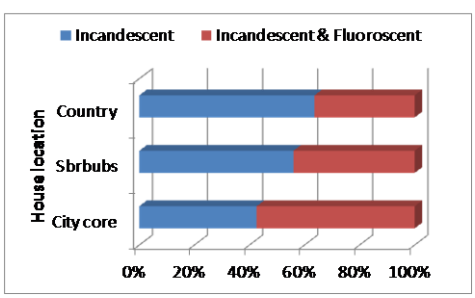

Figure 3. Type of light bulbs used in the house as a function of house location

3.2 Type of light bulbs vs. house location

Figure 3 shows type of light bulbs used in the differently located houses. The investigated houses are in the city core, suburbs, and country side. The investigation shows that the number of houses that use the fluroscent light bulbs is the highest the in the city core. Then, the fluroscent light bulbs are used by 54% of houses while only the incandescent light bulbs are used by 43% of the houses. The use the fluorescent light bulbs is the lowest in the country side. Then, the incandescent light bulbs are used by 64% of the houses, while the fluroscent light bulbs can be found at 34% of houses.

3.3 Type of light bulbs vs. house size

Figure 4 shows types of light bulbs used in the house as a function of its size. The investigated house sizes are "up to 80 m^{2}", 80-120 m^2, 120-200 m^2, and "above 200 m^{2}". Regarding this issue, the investigations did not give any conclusive results.

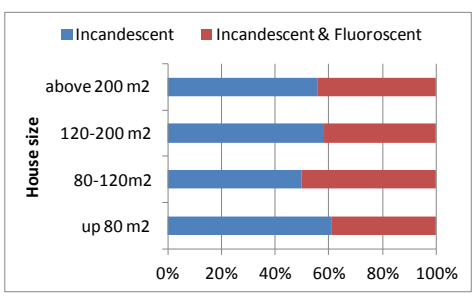

Figure 4.Type of light bulbs used in the house as a function of its size

3.4 Type of light bulbs vs. net income

Figure 4 shows type of light bulb used in the house as a function of the net income in the households. The studied net income ranges are <6k €/a, 6-12k €/a, and >12k €/a. The research shows that the highest application of the fluroscent light bulbs is by the residents with the highest income (>12k€/a). Then, the both types of the light bulbs are used at 63% of houses while only the incandescent light bulbs are used at 34% of the houses. The lowest application of the fluroscent light bulbs is by the residents with the lowest income (<6k€/a). Then, the incandescent light bulbs are used at 64% of the houses, while the fluroscent light bulbs can be found inside 34% of houses.

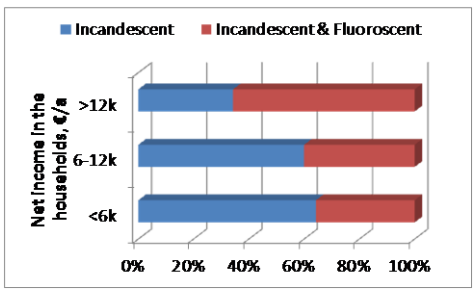

Figure 5.Type of light bulb as a function of the net income in the households

3.5 Type of light bulbs vs. familiarity to save energy

Figure 5 shows types of light bulbs used in the house as a function of familiarity with methods to save energy. The respondents are divided to that with small, good, and excellent familiarity with methods to save energy. The research shows that the highest application of the fluroscent light bulbs is by the residents with excellent familiarity with methods to save energy. Then, the fluroscent light bulbs are used in 64% of houses, while the incandescent light bulbs are used in 36% of the houses. The lowest application of the fluroscent light bulbs is by the residents with small familiarity with methods to save energy. Then, the incandescent light bulbs are used in 65% of the houses, while the fluroscent light bulbs are only used in 35% of houses.

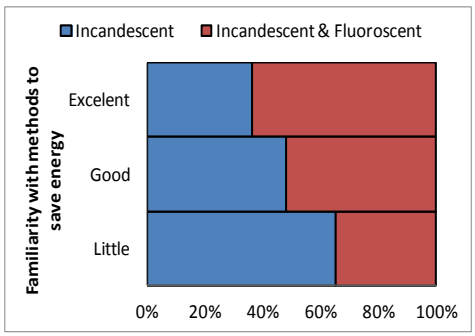

Figure 6. Type of light bulbs used in the house as a function of familiarity with methods to save energy

4. CONCLUSIONS

This paper presents results of the survey of the use of lighting in the Serbian houses in city of Kragujevac. The results may be valid for other Serbian cities and should be taken into account when designing any Serbian energy policy. The investigation found out that

1) The survey shows that the highest number (56%) of the tenants only uses the incandescent light bulbs in their houses.
2) The pure application of the fluorescent light bulbs is very low.
3) The investigation shows that the fluorescent light bulbs are the most often present in living rooms and have the lowest presence in the bathrooms.
4) The investigation shows that the number of houses with use of the fluroscent light bulbs is the highest in the city core, and the lowest in the country side.
5) Regarding the size of the house, the investigations did not give any conclusive results.
6) The research shows that the highest application of the fluorescent light bulbs is by the residents with the highest income (>12k€/a). The lowest application of the fluorescent light bulbs is by the residents with the lowest income (<6k€/a).
7) The research shows that the highest application of the fluorescent light bulbs is by the residents with excellent familiarity with methods to save energy. The lowest application of the fluorescent light bulbs is by the residents with small familiarity with methods to save energy.

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Acknowledgment: This investigation is part of the project TR 33015 of Technological Development of the Republic of Serbia and the project III 42006 of Integral and Interdisciplinary investigations of the Republic of Serbia. We would like to thank to the Ministry of Education and Science of Republic of Serbia for the financial support during this investigation.