

Lighting public buildings in Hungary: energy efficiency potentials and barriers

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ABSTRACT

After a decade of economic transitions in Central and Eastern Europe (CEE), improvements in the extremely high energy intensities have been moderate even in countries where the transitions to a market economy can be considered complete. Publicly and municipally financed buildings house some of the most significant still untapped potentials for energy savings by efficiency retrofits in these countries. Thus, they are prime candidates for major national and international energy-efficiency programs. However, they have only served hesitantly as targets of such programs during the past decade. The reasons for this include significant market barriers prevailing in this sector impeding the financial attractiveness of otherwise cost-effective energy-efficiency investments. Among the market barriers is our major lack of data and information on energy use and equipment saturations in this sector; and thus we have a limited understanding of the energy efficiency potentials and cost-effectiveness indicators.

Recognising this major limitation in information and data hampering energy-efficiency initiatives in this sector, the purpose of the work reported in this paper was to map

the state of lighting systems in the public sector in Hungary; pointing to the magnitude of the efficiency potentials; and to gain an insight into the prevalent barriers to energy efficiency retrofits. The method of research has included the visual audit of the lighting systems in a carefully designed sample of 421 educational and medical facilities in Hungary by trained auditors. In addition, the lighting system decision-makers of the surveyed institutes were interviewed related to their awareness of energy efficiency potentials, barriers to implementation, and to their general behaviour related to lighting system decision-making.

The findings of this research has not only confirmed the significant potentials for energy efficiency improvements in this sector, but also established priorities for energy-efficiency projects. In addition, the research has shed light on a few key barriers to efficiency retrofits that need to be overcome before a widespread effort can be launched to tap these cost-effective efficiency potentials. Beyond the barriers, the paper identifies auxiliary benefits of energy efficiency programs in this sector as well.

To realise energy and cost savings potentials, the paper concludes, a concerted effort is needed from the side of the institutions themselves, municipalities (assisting with at least information), the government (institutional reforms), potential financing institutions, manufacturers, and the energy-efficiency community.

INTRODUCTION AND OBJECTIVES

The fall of the Berlin wall has found world-record energy intensities in the post-communist countries, among other soaring environmental problems (IEA 1997; Ürge-Vorsatz and Szeszler 1999; Chandler 2000). While many govern-

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ments in the Central and East European (CEE) region have placed a high priority on improving the efficiency of energy consumption and production, improvements in the high energy intensities have been moderate even in countries where the transitions to a market economy can be considered complete. The transition to a market economy has provided the missing incentives for the private sector, and the lifting of energy tariff subsidies have corrected the price signals to businesses. These, along with other promoting policies and international programs, have resulted in important refurbishment projects in private companies, and the energy efficiency standards have grown in domestic and new private buildings (Ürge-Vorsatz and Hauff 2001).

However, change in the public sector has been slow. Publicly and municipally financed buildings house some of the most significant still untapped potentials for energy savings by efficiency retrofits in these countries. Thus, they are prime candidates for major national and international energy-efficiency programs. However, they have only served hesitantly as targets of such programs during the past decade. The reasons for this include significant market barriers prevailing in this sector impeding the financial attractiveness of otherwise cost-effective energy-efficiency investments. Among the market barriers is our major lack of data and information on energy use and equipment saturations in this sector; and thus we have a limited understanding of the energy efficiency potentials and cost-effectiveness indicators.

Recognising this major limitation in information and data hampering energy-efficiency initiatives in this sector, the authors of this paper have initiated a representative market research project in municipally financed buildings in Hungary. The purpose of the work was to

- map the state of lighting systems in municipally financed buildings in Hungary;
- contribute to the understanding of potentials for energy efficient retrofits;
- and to gain an insight into the prevailing barriers to such upgrades.

While the focus of this study was Hungarian public buildings, several of the findings, especially the ones relating to key program priorities and barriers, are expected to prevail in the public sector of other CEE countries, and therefore can help energy efficiency programs aimed for this sector in the region.

RESEARCH METHODS

The research was carried out through a representative set of institutional interviews combined with a lighting system audit. A questionnaire was designed by the principal investigator of this research, in concert with the project funders. Several comments on the questionnaire were provided by the three manufacturers and lighting experts. The questionnaire was tested by 3 people before finalisation.

Each institution in the sample was visited in person by the interviewer, where he/she conducted a first level lighting system audit, and interviewed those responsible for

lighting decisions and system maintenance at the institution in detail. The audit consisted of the walking through the entire institution and of the identification of and counting of each lighting system. In case of very large institutions consisting of more than 2-4 buildings, while the interview questions concerned the entire institution, the audit was limited to 2-3 buildings of the institution, depending on how much was possible to be audited during 2 days. Thus, in the case of large hospitals and higher educational institutions, the lamp counts refer to certain buildings only (indicated in the individual questionnaires). Interviewers spent between half a day to two days in one institution, and institution managers needed to certify with their signature that the audit and interviews were carried out in a responsible manner by the auditor.

Interviewers have been selected with relevant higher education degrees. Many of the interviewers had experience with energy efficiency auditing, or participated in such courses before. In addition to their original training, they received a one-day special project-related training.

For the representation of municipally financed buildings in Hungary, 5 institution types were selected:

- Hospitals
- Higher Educational Institutions
- Elementary Schools
- Secondary Schools
- Kindergartens.

A sample of 500 was designed to represent the municipal building sector in a statistically significant way in terms of geographic location, settlement type and size of the municipality, and institution type. Since in Pest county (including the capital Budapest) a large number of hospitals, higher educational institutions and secondary schools are located, and this number is known, there were special numbers designated in these categories for this county to ensure representativeness. The final number of completed and readily processable audits which arrived in time for the statistical analysis is as follows, compared to the total number of institutions in the category in Hungary (Table 1).

Due to the low number of total higher educational institutions and hospitals, they needed to be overrepresented in the sample: in the end, over each third hospital, and almost each fourth higher educational institution in Hungary was audited in this survey. Each interviewer was assigned an individually tailored set of interviews balancing counties, major towns, settlement and institution types to assure national representativeness.

Table 1. Number of institutes surveyed by institute type and settlement type

Institution type	Settlement type					Total surveyed	Total number of institutes in Hungary
	100,000 < town	50,000 – 100,000	20,000 – 50,000	10,000 – 20,000	< 10,000 Village		
Kindergarten	29	9	22	11	71	142	4701
Elementary school	38	9	21	14	72	154	3732
Secondary school	34	6	19	10	2	71	1036
Higher education	9	6	6			21	89
Hospital	8	4	14	6	1	33	155
Total	118	34	82	41	146	421	9713

Table 2. Floorspace in the institute as a function of institute type (number of institutes)²

Institution type	Floorspace in m ²					Total
	1 – 100	100 - 300	300 - 500	500 - 1000	1000 <	
Kindergarten	7	45	33	32	25	142
Elementary school	4	8	6	29	107	154
Secondary school			1	11	59	71
Higher education			2	2	17	21
Hospital				1	32	33
Total	11	53	42	75	240	421

1) Please note that these numbers are only indicative: precise square footage has not been asked, only an approximation

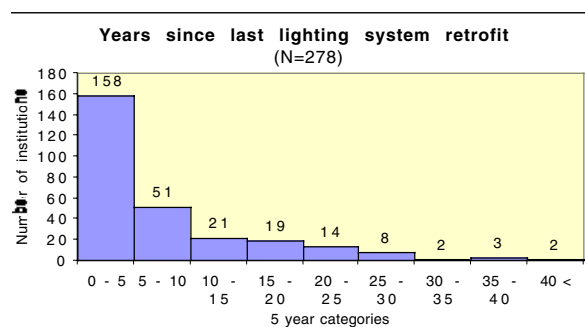
Building and institution characteristics influencing lighting energy use

In order to be able to understand national energy savings potentials and calculate cost-effectiveness of potential retrofits, certain building and institution characteristics influencing lighting electricity use need to be observed. Table 2 summarises floorspace distribution by institution categories.

The building stock of municipal institutions is rather old: two-thirds of the buildings were constructed prior to 1976, 15% prior to the 20th century. On the positive side, the lighting systems in approximately 75% of the buildings are less than 10 years old, and over half of them have been reconstructed or new lighting systems installed within 5 years. On the negative side, over 40% of the lighting systems are older than 15 years, and some are as old as 40 to 50 years.

On average, the lighting systems in municipally funded institutions are Approximately 8 years old. The most recently reconstructed lighting systems prevail in secondary schools, while lighting in higher educational institutes and hospitals have not seen a reconstruction in the longest period. When the last year of lighting system reconstruction is examined as a function of settlement type, it is clear that large cities have seen the benefits of most recent retrofits.

Another important characteristic for the understanding of energy savings potentials is the number of lighting hours in the institute. From the Table 3 it is clear that hospitals

Figure 1. Number of years since the last reconstruction including the reconstruction of the lighting system

should bring the fastest payback times since their operational hours are the longest.

Electricity consumption and payment of bills

The largest institutions consume as much as 380,000 – 2,300,000 kWhs per months, and spend as much as 56 – 348 million HUF (0.3 – 1.3 million Euros) annually on their electricity. This is clearly a substantial amount for the cash-short publicly financed institutions. The largest consumers are hospitals in the big country towns.

Table 3 Average daily working hours of the institute, hours

Institution type	Monday through Friday	Saturday	Sunday	Daily Average
Kindergarten	10.63	0.23	0.23	7.66
Elementary school	11.66	0.43	0.25	8.43
Secondary school	13.60	2.00	1.75	10.25
Higher education	17.81	9.42	8.21	15.24
Hospital	22.34	23.23	23.23	22.59
Average	12.75	2.89	2.72	9.91

Table 4 The average amount of electricity consumed monthly in the different institutions, kWh

Institution type	Flat rate arrangements	No flat rate		Average
		Summer	Winter	
Kindergartens	1,715	1,558	3,185	2,057
Elementary school	4,554	3,539	6,123	4,611
Secondary school	9,798	7,938	11,689	9,880
Higher education	17,800	61,911	98,251	69,979
Hospital	413,765	144,496	165,875	219,967
Average	39,824	22,661	29,448	28,590

Table 5. Do you have problems with the payments of the electricity bills? As a function of who is paying for the electricity bill, number and percentage of institutions.

Payment problems	Who pays for the electricity bill?				Total
	Self	Municipality	Other	No answer	
Never	112 91.1%	185 84.5%	47 87.0%	20 80.0%	364 86.5%
Small delays	5 4.1%	23 10.5%	6 11.1%	2 8.0%	36 8.6%
Regular delays	4 3.3%	3 1.4%	1 1.9%		8 1.9%
No answer	2 1.6%	8 3.7%		3 12.0%	13 3.1%
Total	123 100%	219 100%	54 100.0%	25 100.0%	421 100.0%

Problems with the payment of electricity bills

The non-payment of electricity bills has become a major obstacle in the CEE region to energy efficiency improvements (IEA 1997). While Hungary is one of the least problematic countries in the region from this perspective, it is important to understand the magnitude of the problem.

The majority of the institutions do not have problems with paying their bills in time. However, the exact figures should be used with caution, since Approximately 10% of the respondents have not answered the question, which may imply that some of these do have problems, but are not willing to disclose this information. Municipalities tend to be more relaxed about timely payments, since institutes financed directly by municipalities report the highest number of delays in bill payments. Approximately 10% of all institutions have indicated some kind of problems

with payments, but this is highly variable by institution type. While one-third of all hospitals interviewed have experienced delays or other problems with paying electricity bills, less than 3% (3 out of 133) of kindergartens have had problems with payments. The most problematic county from the perspective of payment problems is Borsod-Abaúj-Zemplén, where one-third of all institutions reporting payment arrears are located.

Description of lighting systems

Table 6 summarises the share of the different lighting technologies by institution type.

The most dominant (46%) lighting technology in municipally financed Hungarian institutions is T12 linear fluorescent tubes (49% of educational institute and 41% of hospital lighting is supplied by such lamps), followed by

Table 6. The share of lighting systems as a function of institution type (the totals are the total count in all audits)

Technology	Institution type					Total
	Kindergartens	Elementary schools	Secondary schools	Higher education Institutions	Hospitals	
Incandescent	5,415 <i>16.45%</i>	9,432 <i>6.91%</i>	8,178 <i>9.01%</i>	14,825 <i>14.44%</i>	46,440 <i>19.36%</i>	84,290 13.99%
Screw-in CFL	504 <i>1.53%</i>	795 <i>0.58%</i>	670 <i>0.74%</i>	1,064 <i>1.04%</i>	2,561 <i>1.07%</i>	5,594 0.93%
Plug-in CFL	304 <i>0.92%</i>	1,480 <i>1.08%</i>	1,692 <i>1.86%</i>	272 <i>0.26%</i>	12,459 <i>5.19%</i>	16,207 2.69%
T8 magnetic ballast	7873 <i>23.92%</i>	35,109 <i>25.73%</i>	24,369 <i>26.84%</i>	59,063 <i>57.54%</i>	74,474 <i>31.05%</i>	200,888 33.33%
T12 magnetic ballast	17,242 <i>52.39%</i>	82,962 <i>60.81%</i>	51,355 <i>56.57%</i>	25,266 <i>24.61%</i>	98,154 <i>40.92%</i>	274,979 45.63%
T8 electronic ballast	1,456 <i>4.42%</i>	5,127 <i>3.76%</i>	3,550 <i>3.91%</i>	1,293 <i>1.26%</i>	2,282 <i>0.95%</i>	13,708 2.27%
Metal halide	52 <i>0.16%</i>	778 <i>0.57%</i>	630 <i>0.69%</i>	314 <i>0.31%</i>	613 <i>0.26%</i>	2,387 0.40%
Halogen	16 <i>0.05%</i>	630 <i>0.46%</i>	219 <i>0.24%</i>	501 <i>0.49%</i>	1,754 <i>0.73%</i>	3,120 0.52%
Other	50 <i>0.15%</i>	113 <i>0.08%</i>	119 <i>0.13%</i>	55 <i>0.05%</i>	1,145 <i>0.48%</i>	1,482 0.25%
Total	32,912 100%	136,426 100%	90,782 100%	102,653 100%	239,882 100%	602,655 100%

T8 fluorescent lamps with magnetic ballasts (33% average, 35% of educational facility and 31% of hospital lighting). Besides the linear fluorescent technology, incandescents are also ubiquitous by constituting 14% of lamps: they are twice more often used in hospitals than in educational institutions (10% vs. 19% of all lamps). Within the educational institution category, elementary schools use the least incandescents (7% of lamps), while kindergartens and higher educational establishments use the most: 14 and 16%, respectively.

The most incandescents in educational institutions are found in lavatories and miscellaneous rooms (above 10,000 each in total), while many of the classrooms and corridors are also equipped by incandescent lamps (above 5000 in total each). In terms of technology penetration by room type, such lamps dominate in lavatories constituting over half of all lamps (57% in educational buildings, 51% in hospitals). Approximately 15% of the lamps found in personnel and miscellaneous rooms in educational institutions are incandescents, while less than 10% of the lamps are provided by this technology in other room types.

Hospitals constitute a larger savings potential in the field of incandescent replacements than educational institutions, since 20% of lamps in patient rooms, close to 19% in doctors' rooms, 16% in staff rooms, and 31% in other room types are incandescents.

In terms of fluorescent lighting, most educational institution types examined own Approximately half T12s and a quarter T8s with magnetic ballasts, besides universities and colleges, who seem to have experienced more upgrades to the T8 technology: penetrations are reverse with 25% of lamps T12s and 58% T8s. Linear fluorescent technologies dominate in each room type in educational institutes, with the exception of lavatories, as mentioned above. This trend holds for hospitals as well, but the domination

of fluorescents over the incandescent technology is not so overwhelming in several of the room types, as indicated above.

The more efficient lighting technologies are used rarely in municipally funded institutions. Only 7% of all lamps are either CFLs, or electronically ballasted T8s, metal halides, halogen or other technologies. Most of the energy-efficient lighting systems used are plug-in CFLs (2.7% of all lamps) or T8s with electronic ballasts (2.3%). Electronically ballasted T8s are most popular in kindergartens (4.4%), elementary schools (3.8%) and secondary schools (3.9%). The most efficient linear fluorescent lighting systems searched for, T8s with electronic ballasts, were found in 62 institutes in the sample. In hospitals, electronic ballasts have been identified in patient and staff rooms and on corridors, but not in other room types. In educational institutions, electronic ballasts are used most in labs (6% of lamps), and also in classrooms (3.5%), personnel rooms (3.6%) and in lavatories (3.3%). Efficiency retrofits to T8s with electronic ballasts have mainly taken place in large cities.

Less than 2% of lamps in educational institutions are CFLs, with .8% screw-in CFLs and 1% plug-in CFLs. Most CFLs are found on corridors and lavatories. Hospitals, however, rely more heavily (6.3% of their lamps) on CFLs, in which the plug-in version dominates by 5.2%. CFLs are mainly used in patient rooms, where 11.4% of all lamps are CFLs.

In terms of the other lighting technologies, metal halides can almost only be found in „other” rooms in educational institutions, which are mainly gyms. Some hospitals use metal halide technologies in operating rooms as well. Halogen lamps constitute less than .5% of all lamps, and they can dominantly be found in operating rooms (5% of lamps), staff rooms, and labs.

Table 7 Average daily usage of the different technologies as a function of institution type

Technology	Institution type					Average for technology
	Kindergartens	Elementary schools	Secondary school	Higher education	Hospital	
Incandescent	4.60	4.17	6.62	6.02	12.77	9.50
Screw-in CFL	4.54	4.45	5.23	7.96	12.48	8.90
Plug-in CFL	4.16	3.64	4.33	6.09	5.37	5.09
T8 magnetic ballast	4.94	5.64	6.09	7.97	9.88	7.92
T12 magnetic ballast	6.23	6.57	7.58	6.66	13.12	9.08
T8 electronic ballast	5.73	6.45	6.16	7.98	13.94	7.69
Metal halide	9.00	4.79	5.34	4.88	15.24	7.72
Halogen	4.03	3.96	6.49	4.24	9.25	7.16
Other	4.01	2.97	6.01	4.98	9.52	8.39
Average for institute type	5.58	6.09	6.94	7.33	11.60	8.60

In conclusion, there is a considerable untapped energy saving potential in these institutions with approximately 93% of lighting served by lighting technologies, which can be retrofitted by more energy efficient alternatives.

Lighting system operating hours

For the calculation of energy savings potentials and cost-effectiveness of lighting

system retrofits, it is important to understand typical operating hours. The following table reviews the average daily usage in operating hours of the different lighting technologies. The data emphasise the importance of channeling lighting retrofit projects towards hospitals: hospitals use their lighting systems approximately twice as much daily as educational institutions, thus shortening payback times significantly.

Another important result is the relatively short daily operational hours of plug-in CFLs: they are used approximately 40% fewer hours than incandescent lamps. While this may be a result of some bias in the survey, there is no indication for this. This fact definitely raises the question whether incandescent replacements have been designed in the economically most optimal way during lighting system retrofits.

Satisfaction with lighting systems

Dissatisfaction with the present lighting system of the building occupants can provide an important motivation for lighting system retrofits. Therefore, the research has placed an important emphasis on the level of satisfaction with the systems. The table below contrasts the satisfaction with the lighting system to the dominant lighting technology in the institution. While the users of most technologies are neither satisfied nor dissatisfied, in institutes where incandescent lamps dominate, they seem to be the least satis-

fied. Users are surprisingly most satisfied with the most efficient technologies: CFLs and electronically ballasted T8s. (Table 8)

Hospitals and higher educational institutions tend to be the least satisfied with their lighting systems, while the highest share of satisfaction is reported from kindergartens. However, one-fifth of kindergartens also report dissatisfaction with their lighting systems, thus the quality of systems in kindergartens show the highest variability.

Respondents were asked to name specific lighting system related problems causing dissatisfaction in an open-ended question. A large number of institutions have complained about the obsolete lighting systems, including old and unsafe wiring, transformers, old and noisy luminaires, obsolete ballasts and lamps. Luminaires have received the largest number of criticisms: often they cannot be cleaned, they are in poor condition and fall apart, the louvers do not function, spare parts cannot be replaced, and they generate noise during operation. The technical problems raised with luminaires and wiring included missing caps, missing fuses, fire safety concerns and contact problems. Luminaires were also identified as important targets for efficiency-oriented retrofits.

About the same number of complaints were raised against the humming and flickering of linear fluorescent lamps. Also a large number of respondents complained that there is not enough segregation in the lighting system: it would be helpful if certain segments could be switched on independently of each other. Non-lamp related lighting system problems named included the unstable voltage, unstable electricity supply and frequent blackouts, and that the fuses go out as the lamps are switched on. System overloads as a result of switching on of the lamps were reported by several respondents.

Table 8. User/administrator satisfaction with current lighting systems

Dominant Technology in institution	Satisfaction with lighting system			Total
	Very good	Average	Poor	
Incandescent	4 11.8%	15 44.1%	15 44.1%	34 100%
Screw-in CFL	2 100.0%			2 100%
Plug-in CFL	1 50.0%	1 50.0%		2 100%
T8 magnetic ballast	19 17.9%	68 64.2%	19 17.9%	106 100%
T12 magnetic ballast	33 13.3%	181 72.7%	35 14.1%	249 100%
T8 electronic ballast	9 47.4%	9 47.4%	1 5.3%	19 100%
Halogen		1 100.0%		1 100%
Total	68 16.5%	275 66.6%	70 16.9%	413 100%

Several institutions complained about inadequate lighting levels, some expected improvement in this from the retrofit of obsolete luminaires. Most illumination related problems were reported in connection with incandescent lamps and incandescent luminaires.

In terms of technical problems raised concerning the lamps, a very high number of institutions (31 out of approximately 100 giving valuable answers to the open-ended question) worried about the fact that fluorescents and sometimes incandescents need to be replaced more frequently than it could be expected based on rated lifetimes. Some respondents owed this to unstable voltage and to the inability of the lamps to tolerate the switch from 220V to 230V in the supply. Several respondent identified brands whose lamps fail earlier than other lamps. A specific concern was raised against the overly high electricity consumption of a metal halogen technology. Approximately half a dozen institutions disliked the colour of the light supplied by fluorescent lighting; one respondent specified that the light of the „biax” lamps irritates the eyes of the workers. Some institutions complained about the unavailability of spare parts.

Lighting system related decision-making

In order to understand the barriers to energy-efficient retrofits, we need to understand how lighting system related decisions are brought. Such decisions are made in most institutions (60%) by the director of the institute. In the case of larger institutions (hospitals and higher educational facilities) usually the heads of the maintenance bring these decisions (72% and 57% of institutes, respectively), while directors also remain as important decision-makers (25% and 33%, respectively). Less than 6% of institutions use others to decide on their lighting systems. Within these, 6% of kindergartens ask outside contractors, while

2-5 % of all institution types uses other ways of deciding over lamp purchases.

In the following section, we address the question how motivated the decision-makers are in improving the efficiency of the lighting systems.

The key criterion influencing lighting system purchases is initial cost, (as indicated in the figure below). However, it is important to note for the interpretation of these results, that some answers included multiple criteria without ranking, and in these cases we chose the criterion first mentioned. Thus, if everyone had chosen truly one key criterion, there may have been more choices for the minimisation of energy costs criterion most frequently co-chosen by those indicating multiple answers) at the expense of lowest first cost or quality. However, the present distribution still represents what the vast majority of institutions identify as key criterion: first costs. On the positive side, 16% of institutions consider quality to be the most important factor in lamp purchases, and 13% of them named minimising energy costs as the single most important factor. Again, more institutions consider the minimisation of energy consumption to be a key factor, but only as equally important as either first costs or quality. Three percent (3%) of the respondents considered other factors driving their purchase decisions.

While approximately the same share of institutions consider the minimisation of energy expenditures as the most important criterion, higher educational institutes seem to be more than twice as efficiency-conscious as the other municipally financed institutions: more than a quarter of universities and colleges audited named energy efficiency the most important factor for light purchases.

Fig 2. Key criterion influencing purchase decisions.

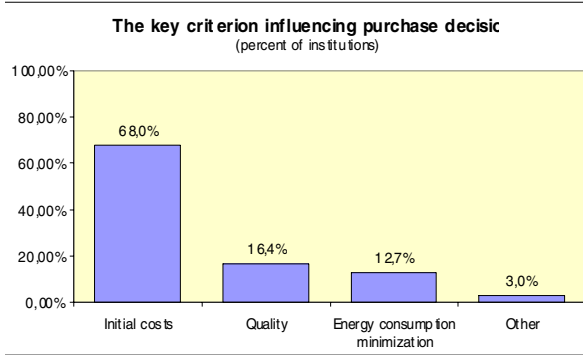


Fig 3. Location of lamp purchases.

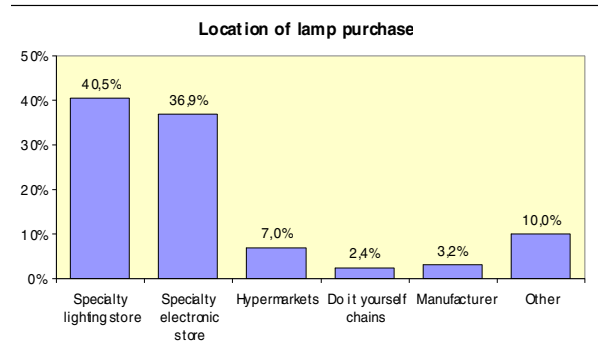


Table 9. Purchasing location as a function of institution type

Institution type	Purchasing location					
	Specialty lighting store	Specialty electronic store	Hypermarkets	Do it yourself chains	Manufacturer	Other
Kindergarten	40.1%	33.6%	10.2%	0.7%	1.5%	13.9%
Elementary school	36.6%	42.5%	5.2%	2.6%	4.6%	8.5%
Secondary school	38.0%	36.6%	7.0%	7.0%	2.8%	8.5%
Higher education	61.1%	27.8%			5.6%	5.6%
Hospital	54.5%	30.3%	6.1%		3.0%	6.1%
Total	40.5%	36.9%	7.0%	2.4%	3.2%	10.0%

Table 10. When do you replace your lamps? As a function of institution type
 May be rephrase in something like "Frequency of lamp replacement"
 (to avoid it being in question form)

Institution type	When do you replace your lamps?			Total
	Only when they burn out	In groups, after some of them do not function	In groups, after some period of time	
Kindergarten	122 88.4%	12 8.7%	4 2.9%	138 100%
Elementary school	134 87.0%	17 11.0%	3 1.9%	154 100%
Secondary school	65 92.9%	4 5.7%	1 1.4%	70 100%
Higher education	18 85.7%	2 9.5%	1 4.8%	21 100%
Hospital	33 100.0%			33 100%
Total	372 89.4%	35 8.4%	9 2.2%	416* 100%

*5 missing answers

The location of lighting system purchases

The location of lighting system purchase can be vital for designing lighting programs. Therefore, the research has also aimed to map purchasing habits of public organisations. The authors expected a major shift in purchasing behaviour during the last decade towards bottom-price hypermarkets and do-it-yourself stores.

However, the majority of Hungarian municipally financed institutions (78%) still purchase their lighting

equipment in specialty lighting and electronics shops. Specialty lighting stores are favored most by the large institutions: more than half of all hospitals and higher educational institutions purchase their lamps there. Hypermarkets (TESCO, Auchan, Cora, Metro, etc.) and do-it-yourself chains (OBI, Bau Maxx, etc.) are mainly chosen by smaller institutions: kindergartens and schools. Only 3% of all organizations surveyed buy their lighting equipment directly from the manufacturer, while 10% choose other distribution pathways. Interestingly, the location of the institution (and thus the proximity of hypermarkets and other larger sales points) does not influence purchase location preference in a significant way. The exceptions are represented by choosing the manufacturer as the direct source of lamps, or other ways of lamp acquisition: 12 out of the 13% of institutes buying directly from the manufacturer are located in large towns, and 17% of institutions in large towns choose different purchase channels than the store types listed here.

As far as the lamp replacement practices are concerned, the vast majority (89%) of institutions purchase and replace their lamps as they fail. Most of the remaining institutions replace lamps in groups, after a few have failed. Only a small number (9 in the entire sample) opt to change lamps on a periodic basis.

Barriers to efficient lighting retrofits

The purpose of this section is to discuss the awareness of energy efficiency potentials and potential barriers to their implementation of these potentials. The first question in this part of the questionnaire referred to luminaire cleaning attitudes: in vain the most energy-efficient lighting system if the luminaires are dirty and impair light transmission.

Almost three-quarters of institutions claim to clean light fixtures once per year. Hospitals seem to be the most diligent in this respect: none of them admitted that they would never clean luminaires, and more than 20% of hospitals clean them on a monthly basis. On the other extreme, higher educational institutions proved to be the least ambitious in fixture cleaning: 35% of them either never clean them, or clean them less frequently than annually (including those who clean them as lamps are replaced, which can be assumed to be less frequent than yearly).

Motivation of lighting system decision-maker

In order to understand motivations for and barriers to energy efficiency retrofits, it is important to know if the person assigned with lighting system related decision-making is really motivated in improving efficiency, or reducing total lifecycle costs. For instance, the case when the municipality pays for the electricity bills directly, whereas lighting investments are made from the budget of the institute, this can obviously cause an important misplaced incentive preventing long-term investments into more energy-efficient systems. While this is a difficult question to ask in a personal interview and thus results should be used with care, the survey has revealed important trends.

More educational institutions (62% average) claimed that their decision-maker has motivation to improve the efficiency of the lighting system than those who admitted that there is no real incentive (27%). This split was very different in the case of hospitals. While only 46% of hospitals are convinced that the decision-maker is motivated to improve efficiency, as many as 42% of them acknowledged that they do not have a real incentive. Since the responses to this question are expected to be positively biased (it is typically the decision-maker itself who is interviewed), the 22 – 42% rate of acknowledged non-motivation is subject to concern. It means that unless institutional arrangements are changed, at least one quarter of schools and close to half of hospitals will not take steps to improve the long-term cost-effectiveness of lighting.

A few open-ended answers were given to the question on decision-maker motivation. Most institutions' motivation originates from the fact that the hospital/school operates financially independently, and thus it is interested in cost minimization. The opposite of this has been raised as the most typical reasoning of non-motivation: the institution does not operate as an independent financial entity; the decisions are not made by the institute; or there is no direct benefit for the institute from the cost savings. Further rationales for the positive motivation included ethical reasons, and that some decision-makers are motivated by individual financial remuneration arrangements as well.

The cost-effectiveness of efficient lighting retrofits

It is important to understand whether the institution perceives the energy-efficiency retrofit of the lighting system as a cost-effective investment. On average 12% of institutions do not believe in the cost-effectiveness of lighting system replacements, while another 6% do not know. It is very important to understand why this 12% believes that such investments are not economic, and thus this was asked in an open-ended question. About one-third of the negative responses are grounded in the fact that the efficiency retrofits have already been carried out, thus we can discount those from the negative responses. Another quarter respondents expressed concerns about the cost-effectiveness of these investments: they believe the payback times are too long, or that it simply would not be economic. The remaining answers revealed a lack of real understanding of the benefits of cost-effective investments: "it is a small institute", "there is enough light", "we are sat-

isfied with the current lighting system" "it may even be harmful to health". A few answers also reflected the lack of awareness of efficient lighting technologies. Only two respondents expressed concerns about the possibility of theft of screw-in CFLs.

In summary, we can conclude that close to 20% of municipally financed institutions need to be educated about the existence and cost saving benefits of efficient lighting systems.

Among those who believe in the cost-effectiveness of efficiency retrofits most do not expect that it will happen. More than two hundred institutions identified financial constraints as the reason for this pessimism. More specifically, some institutes raised concerns about the long payback times, the high first costs, and that only the municipality is eligible to apply for financing for such projects. One school has mentioned that they cannot include such costs into the budget. Less than half a dozen institutes have reported that the retrofits have already been carried out, or they are being scheduled.

Assistance needed for efficiency retrofits

Related to awareness of retrofit related information, institutions are least aware where to obtain financing for lighting system audits. While more than half of institutions do not know where to turn to for the financing of lighting retrofits, hospitals tend to be slightly more aware than others. Information on lighting retrofit support is somewhat more available to institutions where lighting system related decisions are brought by professionals: either the heads of maintenance or by outside contractors.

About a quarter of the institutions identified the municipalities as the sources of some kind of support for efficiency retrofits. No higher educational institutes and only few hospitals (15%) think that the municipality would assist with finding financing, and 21% believe they would finance the retrofit. Schools and kindergartens are the most optimistic towards their municipalities: 24 – 30% of them believe they could get the financing for the retrofit (but not the audit) from their owners.

When institutions are asked what kind of assistance they would need in order to facilitate efficiency retrofits, the vast majority (89%) of institutions answered they would need assistance with identifying financing possibilities. Slightly more than one-third need assistance for an audit, and 22% want information on possible contractors to carry out the retrofits. Nine percent (9%) answered that there should be a person at the institute assigned with this responsibility to make efficient retrofits happen. Hospitals require the most assistance: none of them feel they have adequate information on financing options and close to half would need assistance with audits. Some kindergartens (15%) feel comfortable with their current information on financing possibilities.

Overall, surveys and interviews have shown that the information needs of institutions depend on who brings the lighting system related decisions. It appeared that currently directors are least aware of financing possibilities, while

outside contractors and „other” decision-makers need assistance in less cases.

SUMMARY

This market research on the assessment of the lighting systems in municipally financed buildings in Hungary was prepared partially to support the program design of the Efficient Lighting Initiative (ELI) of the Global Environment Facility (GEF). In addition to GEF and the host institution, the Central European University, the study was also supported by other firms interested in upgrading lighting systems in this sector to more efficient ones: GE Lighting TUNGSRAM, Osram, Philips Hungary, and DÉMÁSZ. The purpose of this survey was to understand the state of lighting systems in municipally financed public buildings in Hungary, to obtain the information necessary for the understanding of energy saving potentials and of the barriers inhibiting the cost-effective energy-efficient lighting retrofits in these institutions. This research aimed at obtaining a representative picture for all publicly financed Hungarian educational institutions and hospitals. The research included detailed visual audits of and interviews with the lighting decision-makers of 142 kindergartens, 154 elementary schools, 71 secondary schools, 21 higher educational institutes and 33 hospitals by a selected group of trained auditors. Some of the key results of the research are summarised in this section.

Hungarian schools and hospitals are generally located in old buildings: more than two-thirds of buildings were constructed prior to 1975. While half of the institutions responding have had their lighting systems retrofitted within 5 years, one quarter of them have lighting systems in place which are older than 10 years, some as old as 25 – 45 years.

The largest electricity consumers are hospitals, which consume on average three times as much electricity as a typical higher educational institute. More than 10% of institutions admitted to have problems with paying electricity bills, among these hospitals are in the worst situation with one-third facing payment problems. Kindergartens are the best situated from the perspective of payments: only 3% of them report any kind of payment arrears.

In terms of technology penetrations, the T12 fluorescent technology with magnetic ballasts dominates in municipal buildings by constituting 48% of all lamps in educational institutions and 41% of lamps in hospitals. The T8 technology also tends to be widespread: T8s with magnetic ballasts represent 35% of lamps in educational buildings and 31% of those in hospitals. Electronic ballasts are used only in a few institutes: 3% of lamps in educational buildings and 1% of lamps in hospitals were found to have electronic ballasts. Incandescents still dominate lighting after linear fluorescent systems: close to 20% of lamps in hospitals, and 11% in schools are incandescents. Compact fluorescent lamps can still be found only in a handful of institutions, comprising less than 4% of all lamps.

As far as satisfaction is concerned, two-third of the institutions are neither satisfied nor dissatisfied with their lighting systems. Institutions where efficient, modern lighting technologies dominate tend to be more satisfied..

Institutions where incandescents dominate, on the other hand, tend to be less satisfied. Kindergartens proved to possess the most satisfying lighting systems with 22% of institutions expressing satisfaction, while hospitals seem to have the poorest systems with only 6% of them satisfied and over 20% dissatisfied. The most typical concerns raised with lighting systems were the obsolete systems including the wiring, transformers, and luminaires; the impossibility to switch parts of the system on in smaller units; and the nuisance from linear fluorescent systems (presumably T12s): flicker and hum. In addition to that many institutes reported that linear fluorescent lamps fail earlier than they would be expected to based on reported lifetimes.

When lighting system related purchase decisions are made, 68% of institutes consider first costs as the key influencing criterion for purchase decisions. While 16% identified quality as the key criterion, many institutions thought that minimising energy costs are also important. Most institutions (77%) purchase lamps in specialty electronics or lighting stores, while hypermarkets and do-it-yourself chains also start to pick up as purchase points.

The most important barrier to efficient lighting retrofits in these buildings is the lack of available finances, or the lack of information on where to obtain financing. However, it is clear that some other information is also missing: several lighting-related decision-makers are either unsure if such retrofits would be cost-efficient or would pay back in a reasonable time, or have misconceptions about efficient lighting which hamper realistic decisions. Thus, education of decision-makers, and information on audits and financing options is vital for a move towards more efficient lighting systems in municipally funded buildings. Decision-makers in many cases are not motivated in reducing electricity consumption, for this institutional reforms are needed to address this problem.

In summary, the survey has shown that hospitals are most in need for energy-efficient retrofits of their lighting systems, and also for assistance for such retrofits. Hospitals use several times as much electricity as other examined institutions and have the highest magnitude of payment-related problems. Hospitals provide lighting by twice as many incandescents as educational institutions thus representing giant energy savings potentials; and they burn their lamps for much longer hours than other building types thus reducing payback times. Hospitals are the least satisfied with their current lighting systems, but they have the least information on where to obtain financing for efficiency retrofits. This can be explained by the fact that there is the least amount of information available to them on where to obtain financing retrofits.

In conclusion, the lighting systems in municipally financed schools and hospitals in Hungary represent significant electricity and carbon savings potential. Ninety three percent (93%) of lighting is served by lighting technologies, which can be retrofitted by commonly available energy-efficient alternatives. The largest untapped potentials and the most important barriers prevail in hospitals. Cutting on the electricity expenditures of these institutions will not only reduce national carbon emissions, but will

bring significant further benefits through reducing costs and improving comfort and quality of services to these institutions themselves, their workers and occupants, the Hungarian municipalities, and last but not least Hungarian taxpayers. To realise energy and cost savings potentials, however, a concerted effort is needed from the side of the institutions themselves, municipalities (assisting with at least information), the government (institutional reforms), potential financing institutions, manufacturers, and the energy-efficiency community.

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