

## LIGHTING AND ECONOMICAL IMPACTS OF HIGH PRESSURE SODIUM LAMP PUBLIC LIGHTING IN PÉCS

by György BORKOVITS

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Nowadays we can witness the greatest development in the period OF the widespread application of high pressure sodium lamps. It is of much greater importance than any periods in the development of public lighting so far. In Pécs, its general appearance dates back to the end of the 1970s.

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## DIE BELEUCHTUNGS- UND WIRTSCHAFTLICHEN AUSWIRKUNGEN DER BELEUCHTUNG MIT NATRIUMLAMPEN IN PÉCS

## L'EFFET DE LA DIFFUSION DES LAMPES SODIUMS SUR L'ÉCLAIRAGE ET SUR LA RENTABILITÉ A PÉCS

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HUNGARY

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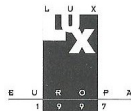
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## ZUSAMMENFASSUNG

Der Ausbau der elektrischen Straßenbeleuchtung begann in Pécs im Jahr 1924. In der vergangenen Zeit ist eine rasante und bedeutende Entwicklung festzustellen.

Besonders vom Ende der 50 er Jahre war die Entwicklung groß, seit dem Lichtrohre in der öffentlichen Beleuchtung verwendet werden, die die vorher allgemein und einheitlich benutzten normale Glühlampe ersetzen bzw. ergänzten. In den 60 er Jahren war die schnelle Verbreitung und Anwendung der Quecksilberlampe in der Straßenbeleuchtung ein weiterer Meilenstein in der Entwicklung.

In den heutigen Tagen sind wir Zeugen des größten Entwicklungsprozesses, als die Hoch-drucknatriumlampen generell verwendet werden. Diese Entwicklung der Straßenbeleuchtung hat viel größere Bedeutung als alle bisherige.

Die Erscheinung der ersten Hochdrucknatriumlampen in Pécs kann man am Ende der 70 er und Anfang der 80 er Jahren datieren.

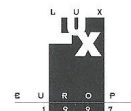
In den 80 Jahren war die Montage von Natriumlampen in der Innenstadt gefördert. Später wurden auch außer der Innenstadt Beleuchtungssysteme mit Hochdrucknatriumlampen aus-gebaut bzw.umgebaut.

Die Gruppe aus Pécs des Ungarischen Elektrotechnischen Vereines (ungarische Abkürzung MEE) hat eine Studie "Untersuchung der Entwicklung der Straßenbeleuchtung in Pécs" verfasst, um die immer steigenden Beleuchtungskosten der Stadt zu reduzieren. In der Studie schlugen wir vor, den Problem mit der weiteren Einsetzen von Natriumlampen zu lösen.

## RESUMÉ

Le début de l'éclairage public fonctionné par le réseau électrique était en 1924. Depuis ce temps le développement était rapid et très important. Particulièrement de la fin des années 1950 le développement était grand pendant le période d'utilisation de la lampe fluorescente à l'éclairage public. La lampe fluorescente a changé ou complété l'incandescence standard utilisé généralement sur les réseaux des éclairages publics. Pendant les années 1960 la diffusion large rapid et l'utilisation de la lampe à vapeur de mercure dans l'éclairage public était un grand pas nouveau et très important. De nos jours nous sommes les témoins d'un grand proces du développement dans l'époque d'utilisation générale de la lampe sodium haut pression, qui a apparu à Pécs à la fin des années 1970.

Depuis 1980 l'utilisation de la technique de sodium s'est accélérée à la cité de Pécs.



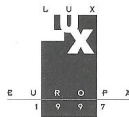
La construction ou reconstruction des systems de la lampe sodium haute pression a commencé aussi dehors de la cité sur les autres terrains de la ville. En novembre 1987, Société Electrotechnique Hongrois de Pécs a préparé une étude:

"Expertise du développement de l'éclairage public de la ville de Pécs" pour Municipalité de Pécs de diminuer les facture montantes de l'éclairage public. Nous avons proposé une solution d'utilisation notable des lampes sodiums pour l'éclairage public de la ville.

## ABBREVIATURE

The development of electric network operated public lighting was started in 1924. Since that time development was rapid and significant especially from the end of the 1950s when fluorescent lights were applied in public lighting, which took the place of and supplemented the earlier commonly and universally applied tungsten filament lamps in the street lighting networks. These fluorescent lamps brought significant development to illuminating engineering because of their better light utilisation and longer life cycle compared to normal bulbs. Another important landmark in the development of public lighting was the big scale and rapid spread of mercury-vapour lamps in the 1960s. The light utilisation of mercury-vapour lamps is double compared with fluorescent lamps and it is four or five times more compared to normal bulbs. Their life cycle is three or four times longer than that of fluorescent lamps and it is eight or nine times longer than that of normal bulbs.

Nowadays we can witness the greatest development in the period OF the widespread application of high pressure sodium lamps. It is of much greater importance than any periods in the development of public lighting so far. In Pécs, like in our country its general appearance dates back to the end of the 1970s the working out of the enhanced illumination for pedestrian crossings dates back to the beginning of the 1980s. Later on they were used for lighting pedestrian areas and walking streets, too. We applied high pressure sodium lamps for illuminating a whole street situated in the historical centre of the town till 1985. Since the Minister of Industry's number 11/1985.(30. November) decree on public lighting came into effect the planned street lighting has been designed applying sodium lamps everywhere. The public lighting on the area of the Siklós district, the built after it and on the following construction sites (Nagyárpád district and so on) and all over the area of the downtown were carried out in accordance with this decree.



In 1974 DÉDÁSZ (South Hungarian Electricity) its study „The Modernisation of Public Lighting in Pécs from 1975 to 1980”. We conducted an examination on the whole area of the town to assess the demand for modernisation which appeared during the working out of the study and to identify what is to be done. During the examination the aim was to achieve the lighting level required in the standard based on the data coming from the classification of roads in accordance with the traffic requirements.

In the period between 1975 - 1980 DÉDÁSZ Electricity conducted significant modernisation of the public lighting system in about 40 streets. In the last year of the plan period the high pressure sodium lamp (put into operation in December 1980.) (in ball shape lampcases) street lighting was installed in a walking street called Ferencesek Street (former Sallai Street). The atmosphere of this lamp is suitable for a walking street: it had been the first sodium lamp street lighting at DÉDÁSZ Electricity.

From the 1980s the installation of sodium lamps in the Downtown was fastened up, the most significant part of this work was the building up of modern lighting system in Széchenyi Square.

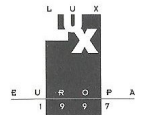
The building up or the re-building of high pressure sodium lamp lighting system was started in other areas of the town beside the Downtown. In order to decrease continuously increasing electricity bill of Pécs's street lighting the Pécs organisation of the MEE (Hungarian Electrotechnical Organisation) prepared the study „The Examination of the Development of Public Lighting in Pécs” for the Pécs Town Council's Executive Committee in November, 1987.

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#### INTRODUCTION AND PRECEDING EVENTS

##### The Connection between Pécs's Town Planning and the Development of Street Lighting:

Looking at the present state of the town and in the case of realisation of the development conceptions required by the development plans the role of the town's public lighting (roads, streets, squares, parks and so on) is very significant. The compulsory lighting level in the existing walking areas and in those walking areas where the buildings are built at the same time as houses are regulated by decrees. Lighting is needed for maintaining life, public and possession security as well as for creating the general well being of the public, which are closely related to each other.



##### Basically, the relation of town plans and related public lighting tasks can be divided into two categories.

I, The ÁRT<sup>\*</sup>, RRT<sup>\*\*</sup> and development plans and then execution plans determine the public lighting needed in the housing estates which are being built and in their public areas. Their realisation takes place by considering the public lighting decree, public lighting standard in force all the time and sometimes considering arising special demands. The up-to-datedness of public lighting equipment and because of it the illumination are determined by supporting structures, lamp shades, illuminants available at the time of installation and the level of up-to-datedness of the supplementary electric equipment needed for their operation.

On the basis of the development of technology it is known that the equipment built twenty years ago which is then said to be the most modern one is not up-to-date today and the equipment installed today will not belong to the most modern ones in twenty years' time.

That is why when setting up and modernising public lighting it is of high importance to apply the technically most suitable street lighting equipment available at the time in coordination with the most modern principles.

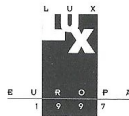
II, The other category: reconstruction of existing districts and the restoration, expansion and modernisation of the existing or partially existing public lighting of streets, roads, parks and other walking areas replanned in course of the reconstruction. In these places normally the whole public lighting system (electric cables, supporting structure, lampshade, illuminants and their appurtenances) needs to be renewed.

The reason for this: partly the new demands, altered functions, reclassification of roads and streets as well as worsening of conditions of the equipment and their obsolescence and their bad light utilisation make their complete renovation necessary. Of course here the regulations of the public lighting decree and standard are to be applied (or authoritative), too.

The planning of the street lighting system is always determined by road plans and the demands based on the functions coming from them.

In the plan phases of the ART and the RRT the coordination of the illumination levels only in case of classification of planned roads is possible on the theoretical level and the investment can be determined only by cost estimations.

\* General Town Plan  
\*\* Detailed Town Plan



The development of public lighting in Pécs is determined by the following data (without specification):

Year	Illuminant piece	Installed Performance kW	Public Lighting Bill Million HUF	Credit Redemption Million HUF
1924.	45	2,7	X	
1930.	1712	141,0	X	
1940.	2667	146,0	X	
1946.	2469	90,0	X	
1960.	3723	214,0	2,1	
1970.	16192	1060,0	5,0	
1970.	16192	1060,0	5,0	
1980.	26392	3850,0	31,9	
1986.	28895	4650,0	66,2	
1987.	28992	4890,0	72,5	
1990.	27550	3957,0	78,3	
1991.	26230	3563,9	102,3	+13,0
1992.	26320	3565,8	104,4	+13,0
1993.	25292	3253,5	103,0	+13,0
1994.	27609	3176,3	95,0	+13,0
1995.	27610	3171,0	83,0	

Remark: X means no available data!

#### The Phases of Public Lighting Development in Pécs

In the past period serious efforts were made to modernise the public lighting system of Pécs. Between 1960 and 1965 and following the years between 1965 and the 1970s DEDÁSZ Electricity reconstructed the network in different districts of the town, in roads and streets which are of importance from the point of view of illumination to a lesser or greater degree.

Thus for instance the West area of the Downtown's middle road execution illumination was implemented and the two sides of Mártírok Street were supplied with mercury vapour lamps with steel pipe supporting structures and Hargita Street and Uzsok street with lamp post illumination. Beside these there were some minor renewals which took place in different areas of the town.

DEDÁSZ Plc.'s Technical Development Department prepared the investment proposal and a draft for the years between 1965. and 1970. to better the public lighting situation.



Due to financial difficulties the execution of the planned modernisation work was only under 50% completion. The worsening of the general situation in this period was enhanced by the obsolescence proportion appearing in the meantime.

Nevertheless on the bases of the balance sheet of the years between 1970. and 1975. in this field some development could be experienced. One of the most important public lighting network building out happened in the area limited by Kaposvári Street, Budai vám and Fehérhegy and then on the Motorway No. 6 on Zsolnay Street from A/1 Petőfi Barracks to 48-as Square. Modern public lighting was installed with the construction of 18 lightpoint height mushroom shape lampcases in Kossuth Square, in Hal Square, at Fehérhegy Bus Terminal. In 1972. the illumination of the Mosque and the Television Tower, the public lighting of Misina Peak and the decorative lighting of the Liberation Monument of those days were prepared. Modern street lighting was built up in József Attila street, which was prepared considering the fact that it will be the section of No. 6 Motorway going through the town.

In these days the public lighting network of Jurisics Street, Mecsek Street, Mikszáth K. Street and Nyil Street was built out. Naturally doing it we did not get even close to solving most problems. Only a smaller part of the roads and streets of higher importance received the required appropriate illumination.

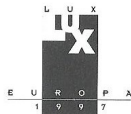
In 1974. DEDÁSZ Electricity prepared the study „Modernisation of the Public Lighting in Pécs in the Years 1975-80“.

During the working out of the study an examination of the whole town area was conducted to assess the modernisation demands and to identify what is to be done. At the examination the basic data was the classification of appropriate road classes on the basis of the traffic and using this data the aim was to achieve the illumination level required by the standard.

The survey and the examination showed that about 80 km of the illuminated streets of the town do not meet the lighttechnical requirements determined in the standard that time in force. Then it meant 45% of the town's illuminated streets.

The study suggested which public lighting networks are to be rebuilt in order of their importance it listed the streets, gave technical solutions as well as cost calculations about the expected sum of the finished work. Then the public lighting network consisted of 42% cable and 58% overhead wire lines.

The study stated it already then that the public lighting network with fluorescent lamps was not up-to-date.



At lamp places with built in performance of 3X80 W or 8X20 W the protecting translucent cover material's fatigue and obsolescence greatly decreased the translucent capacity. Above it the light dispersion because of its lighting capacities and the smoothness of the illumination was not adequate. Since then in many places (in a section of Király Street and in Jókai Street) we managed to rebuild the remaining fluorescent lamp street lighting though in some places the 4.2 m lightpoint height, 8X20 W built in performance street lighting is still waiting for urgent modernisation.

As a result of the town development during the years the earlier insignificant streets has become more important from the point of view of traffic and public security. The illumination of these streets was not completed in some cases or it does not meet the demands and requirements today.

Of course, the study did not deal with the examination of the public lighting of the new housing estates because when building housing estates the most modern street lighting system was planned and carried out automatically.

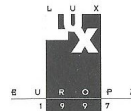
The 1970.-1975. the public lighting program was drawn up in „The Co-operation Agreement” between Pécs Town Council's Executive Committee and DÉDÁSZ Electricity Headquarters.

Most of the most significant tasks had been completed.

The required decorative illumination of Barbakán and the Cathedral of Pécs have not been carried out till today.

By 1975.-1980. Pécs Town Council's Executive Committee and DÉDÁSZ Electricity Headquarters made an economic agreement, in which among others the development of public lighting and decorative illumination were stated to be important tasks. In the plan period the 51 million Hungarian Forints, which were to be spent on it from public taxation, were used up completely. There were some stressed tasks: main roads of the Siklós district, Motorway No. 58., Central Bus Station, Motorway No. 6., Petőfi Str. up to the Pellérd junction (Kaposvár Road North section, Kaposvár Street, Táncsics Street, Petőfi S. Street, Klimó Street, Hősök Square, Ferencsek Street and so on).

During the years between 1975.-1980. DÉDÁSZ Electricity modernised the public lighting system in about 40 streets. During the last years of the plan period street lighting with high pressure sodium lamps was installed suiting the atmosphere of the walking street (put into operation in December, 1980.).



During the years between 1980.-1985. the typical characteristic of the street lighting network development was the planning and building up of the so called nostalgia public lighting system worked out for the rehabilitation-reconstruction plan of the Downtown of Pécs, meeting the demands, and calling back and creating the air of the historical Downtown.

In this period the break in of the high pressure sodium lamp's wide application in all fields of street lighting is very typical.

The most important principles of the DÉDÁSZ Electricity Headquarter's plan panel's resolution:

- The public lighting network should be built up with underground cables. When choosing the supporting structure for the public lighting bracket light and lamp post variations are proposed. The preferred one from the two is the bracket light one!
- The type of the illuminant is the high pressure sodium lamp in the roads around the Downtown of Pécs and on the roads where the traffic goes through the Downtown.
- In walking streets the sodium lamp illumination applied in Ferencsek Street is authoritative.

From the 1980s the use of sodium lamps in the Downtown was spreading: in 1982. in Flórián Square, in 1984. in Zrínyi Street, Mátyás király Street, Irgalmasok Street, Kossuth Square, in 1985. the East section of Király Street, Citrom Street, in 1986. Jókai Street, Elefántos block and the most significant work of the past years was the installation of the new public lighting in Széchenyi Square. Pécs has been the first town in Hungary to build up such a public lighting system, which received beside standard lighting (with RT 3 light thrower) decorative kind of street lighting equipment strengthening the atmosphere of the historical Downtown.

Outside the Downtown in other areas of the town the building up or reconstruction of sodium lamp public lighting systems was started.

The level of illumination has increased. At the same time with the modernisation of the illumination of Kossuth Square and Hal Square, we modernised the illumination of the Fehérhegy bus turning („mushroom shaped”) with the same method as we applied for Kossuth Square. Sodium lamp lighting was given to the North road's broken down, old mercury-vapour lamp lighting and the new streets around the former „Pioneer House” in Uránváros. The „South Connecting Road” was supplied with sodium lamp lighting.



In 1986, we started changing the illumination of the Pécs section of Motorway No. 6, to sodium lamp lighting with the use of posts and the network by changing the lampshade, illuminant and its gear and the wire in the post going to the lamp.

In the letter of DÉDÁSZ Electricity dated to 4. November 1985, to the Town Council of Pécs we suggested that we should accelerate the build up of the sodium lamp illumination in Motorway No. 6.. At the same time we completed the sodium lamp illumination of the lower part of Szent István Square in 1987.

The reconstruction of the lighting of the streets of the historical Downtown was prepared with the application of „Pécs” type cast-iron brackets and „Budavár” type lamps (with 70 W Sodium lamps). In Széchenyi Square we built in „Pécs” type shepherd’s hook kind of cast iron posts with 11 m lightpoint height, „Gisella” type lamps and 150 W high pressure sodium lamps (decorative lighting) . In Irgalmasok Street the new street lighting was built up with Z<sub>2</sub> lampcases and 250 W sodium lamps.

The characteristic of the street lighting network in Pécs is that in the centre the equipment includes cable network with steel pipe post supporting structure. In the outskirts of the town we installed solid or mashed cast iron posts with arms (to supplement the posts) or without arms, closed type, but mostly we installed open type lamps. Here the street lighting network consists of overhead wires and goes through the same post system as the low voltage overhead wire (insulated overhead wire) system.

The issue of the public lighting of the Motorway No. 6, going through the town, the two figure motorways going out of the town, the fly-overs and the connecting roads of the districts lying to the North and South of the rail line have always been of greater importance than normal street lighting.

The outstanding areas of the existing public lighting system: Uránváros and the Mecsek district the street lighting of which together with the housing estates built in the 1950s-1960s in accordance with the decrees and standards in force then. They do not meet the demands of our days in any way (condition, lighttechnical requirements and so on). The new districts Megyeri Kertváros, Sıklós district from block No. 1.-6. received mercury vapour lamp illumination and operate this way today, the sodium lamp installation for which is happening continuously depending on the financial possibilities. Nevertheless, the building up of street lighting structure unit number 7. is with sodium lamps from the very first phase everywhere in Nagyrápad district, the build up of block number IV. was also started this way.

Because the high pressure sodium lamp as illuminant is energy saving, the application of it will be compulsory in the future as well.



The planning of the illumination of new roads, streets will happen according to this. The electric power usage needed to operate the public lighting equipment of the town can be reduced fast and effectively only this way. The continuously increasing operating costs can be stopped or decreased. The tasks related to it which are to be done in 1985. -1990. are included in the „Co-operation Agreement” made between DÉDÁSZ Electricity and the Town Council’s Executive Committee. (The development tasks of the public lighting and decorative lighting in Pécs.)

In many areas of the town trees and bushes cover the lamps and illuminants. This way 50-80% of their given out light is lost in many cases. One form of saving energy is to take care of cutting the branches. Of course we must protect the precious trees and they must only be cut to the extent that they do not cover the illuminants so that the light gets to the road surface free without any losses. In the future we will have to find a solution for this with united forces and make public lighting operate economically. (illustration)

The Measures of the Town Council and later Local Government’s Office to Solve the Budget Deficit

The big scale modernisation and most of all the standardisation of the public lighting together with built in performance increase of the public lighting and the tariff price increase for public lighting (performance, price of power) made the Town Council of Pécs refuse to pay the 73 million HUF annual public lighting bill referring to town’s budget deficit. Because of it they introduced limiting measures in the operation of the public lighting system. It tried to support its measure with the agreeing declarations of the authorities in power. The main point of it was that in order to decrease the public lighting operation bill it arranged that for October, November and December 1987., which is a period when it gets darker earlier anyway, the public lighting switch on according to the calendar ( in our case twilight switch on) happened 20 minutes later and the dawn switch off 20 minutes earlier.

It was the strategy of the Town Council of Pécs for decreasing the public lighting bill.

The work committee formed from the MEE Pécs Body members offered for the Town Council to prepare the study of public lighting modernisation in Pécs, which meant energy saving high pressure sodium lamp public lighting overall and general introduction into the town.

An appropriate schedule was prepared in the study to realise the program. The working out of the study was preceded by the recorded instrumental testing on the basis of which the working committee decided the value of



necessary illuminants (for sodium lamps) for their modernisation watching for the lighting values (requirements specified by standards) belonging to the road classes.

The study determined the cost of the necessary reconstruction investment specifically and by item referring to road routes. Furthermore it stated the efficiency („H“ factor) and the return of the investment in question for years with the help of calculations.

On the basis of the study on the modernisation of the public lighting in Pécs it gave a schedule for the years following 1987. for the Pécs Town Council which gave the sum of the necessary investment and the decrease of the town's public lighting bill.

#### Final Conclusions

The application of sodium lamps began in the first place in the most built up performance routes with the change of high-pressure illuminants with 2X1000 W mercury-vapour lamp, 4X400 W mercury-vapour lamp, 2X400 W mercury-vapour lamp, 2X250 W mercury-vapour lamp, 2X125 W mercury-vapour lamp, 1X250 W mercury-vapour lamp lamp places. The type of most of the applied lamp shades are made by TUNGSGRAM- Schröder Plc. Z<sub>2</sub> model with the exception of Motorway No. 6. going through the town on which the operation principles of those days insisted on the two illuminant lampshade and that's why instead of the 2X1000 W mercury-vapour lamp the 2X250 W sodium lamps were realised with a different company's different model lamp shade.

For the substitution of 80 W mercury-vapour lamp illuminant (in EKA 21-12-101 model lamp shade) some measures have been made and their places were taken by Axiál model lamp shades made by TUNGSGRAM- Schröder Plc. with 35 W compact fluorescent lamp illuminant (100 pieces with experimental nature and excellent experience).

The proportion of the use of different model lamp shades between 1990.-1994. is illustrated in the enclosed table and graph (table no. 7. and graph no. 7.).

The significant impact of the application of sodium lamps on the decrease of the public lighting bill for the town of Pécs is illustrated in the enclosed graphs (graph no. 2. and graph no. 6.).

It is an unfortunate fact that in the past few years the Local Government of Pécs cannot invest in modernisation due to its budget deficit.



Of course, a significant part of the public lighting of the town operates with sodium lamp illuminant, which we can prove by built in performance decrease with the enclosed graphs, which resulted in the decrease of the public lighting bill.

Nevertheless the continuously increasing public lighting tariffs (performance tariff - power tariff) worsen this significant modernisation, but the situation would be even worse without the implementation of the sodium lamp programme ( graphs no. 4., 5. and 6. and tables no. 4. and 6.).

The basic condition for the effectiveness of the use of sodium lamps was the previous modernisation: the complete build up of network posts and so on, with standard mercury-vapour lamp illumination (in some cases even above it). The investment in the installation of sodium lamps was effective only this way because during the energy saving reconstruction of the modern illumination the gearings operating the illuminants and „the reconstruction of the overhead lines“ (with 2,5 mm copper wires) were necessary.

The reconstructed energy saving sodium lamp illumination had not only economic success but also compared to the modern mercury-vapour lamp illuminants lighting the sodium lamp lighting - with keeping the strict regulations of the road illumination levels - it seemed to mean a step back from the point of view of optical physiology. We have to admit that for the specified modernisation (mercury-vapour lamp) many times we lit the roads above the specified illumination level and the change to the standard level worsened the illumination we got used to. Saving energy and achieving economic savings demanded this step.

We can state that it is obvious that the most modern lampcases and increasingly long life high-pressure sodium lamps have been built in which resulted in the implementation of modern, energy saving, reliable public lighting. And this is a great achievement!

The unpleasant accompanying feature of the implementation of the high efficiency energy saving (high-pressure sodium lamp) public lighting is that the light dispersion of the mercury-vapour lamp, with mostly two illuminant lampcases was not the same (designed to be even) as the one illuminant, new sodium lamp lampcases. That is why the result of the modernisation is the worsening smoothness of the illumination and the illumination on the roads will be tarnish. The other damaging factor is that sometimes the stiched or curved arms illuminate the other side of the streets when using mercury-vapour lamp illumination after the standard road design mercury vapour lamp illumination the sodium lamp lamp shade is firmly fixed to unchanged angle standing arm. The existing arm divisions are not always ideal for the smooth light division. The build up and the efficiency of the energy saving sodium lamp public lighting is the price for the fast return of the investment.

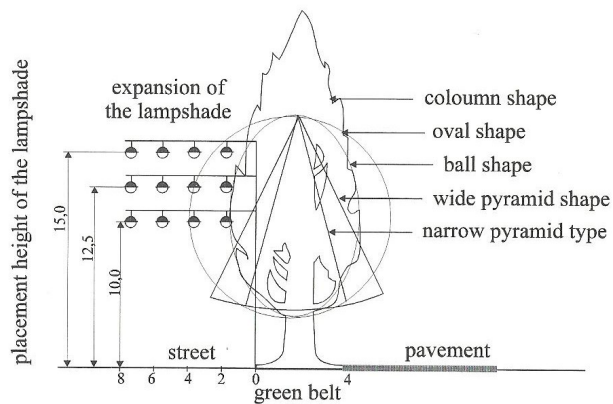


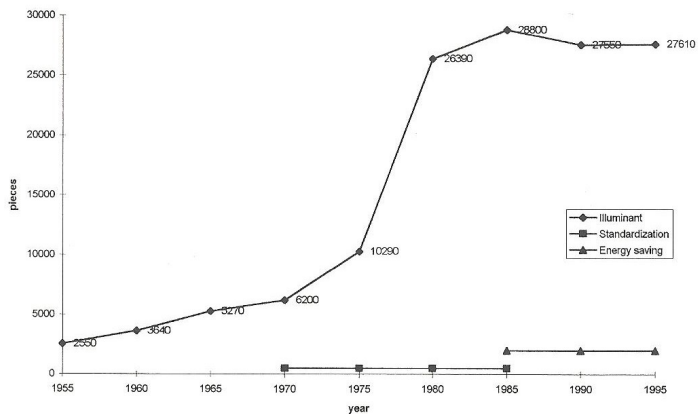
Illustration no. 1.

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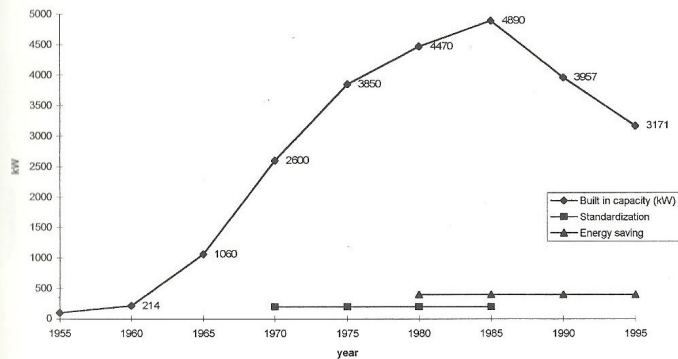


**The change of number of pieces of illuminants in Pécis  
between 1955-1995**



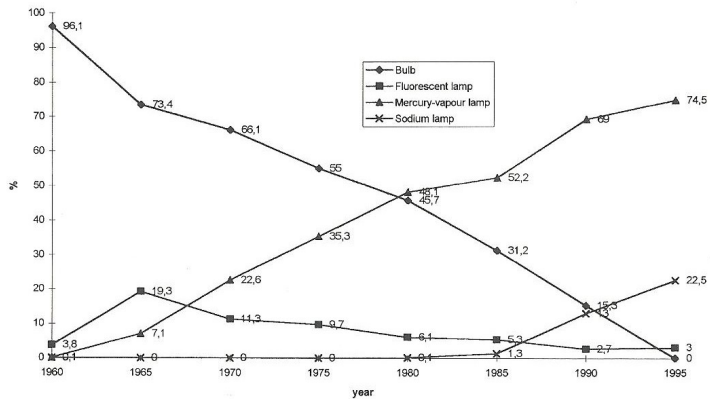
Graph no. 1.

**The built in performance of the public lighting in Pécis  
between 1955-1995**



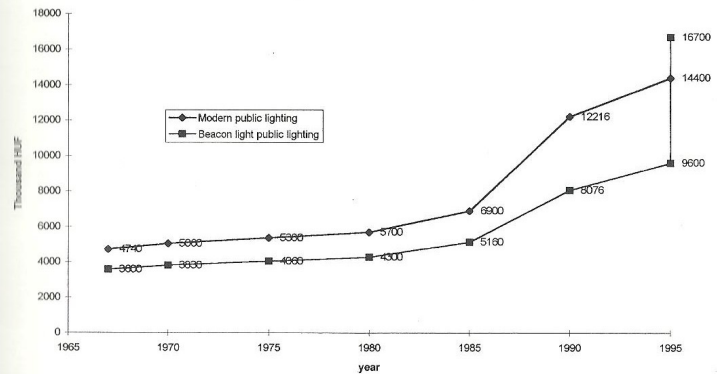
Graph no. 2.

Technical and economic indexes of the use of sodium lamps



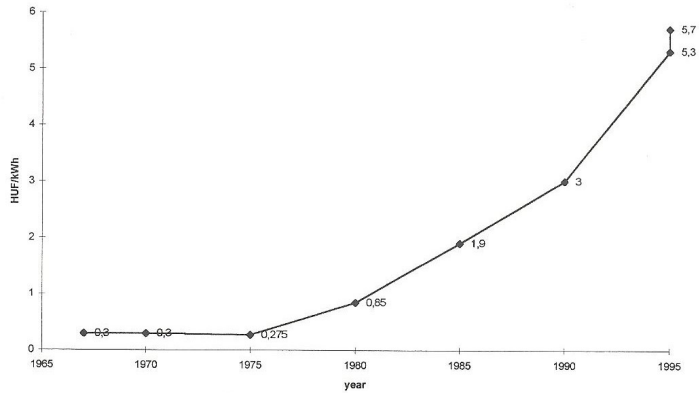
Graph no. 3.

The changes in performance tariff (beacon light and modern public lighting) between 1967-1995



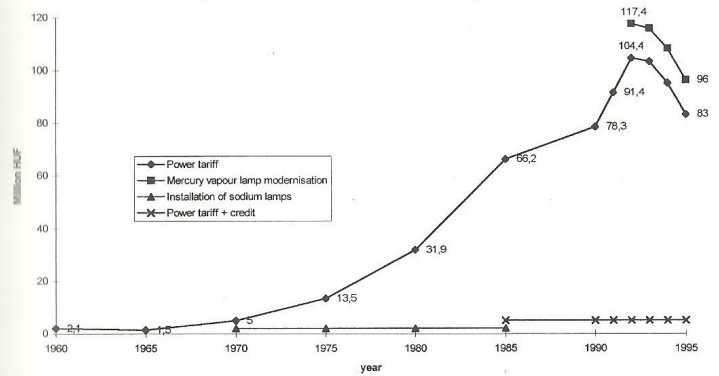
Graph no. 4.

The power tariff between 1967-1995



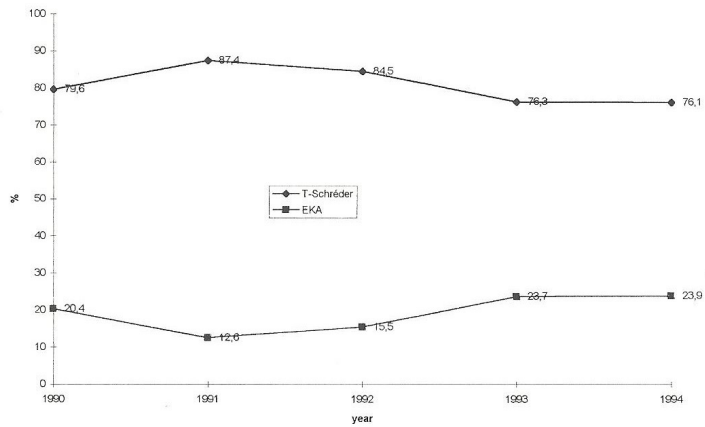
Graph no. 5.

Public lighting bill of Pécs  
 (performance tariff and power tariff) between 1960-1995



Graph no. 6.

Lamp shade usage of DÉDÁSZ plc. in 1990-1995



Graph no. 7.