

A Study of Saving Electrical Energy in the State of Kuwait by Reducing Power Consumption in the Street Lighting Networks

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ABSTRACT

This paper intends to briefly demonstrate the saving of electrical energy in the street lighting networks in the State of Kuwait. This has been done through various steps and phases, such as changing the mercury lamps with high pressure sodium lamps, installing of Program Logic Controller (PLC) system in some roads, and finally applying the reduction power system using Street Lights Dual Power Dimming type in the street lighting networks. Ministry of Electricity and Water (MEW) is responsible of the street lighting networks; therefore we will introduce some data brought from MEW to support our study as a case study.

KEYWORDS: Saving Electrical Energy, Program Logic Controller (PLC) System, Power Reduction System, Street Lights Dual Power Dimming type, and Street Lighting Networks.

I. Introduction

Energy saving in general is a worldwide issue and concern, and electrical energy is among these energies. In the State of Kuwait, Ministry of Electricity and Water (MEW) has taken great steps in order to save electrical energy. One of these steps is to save electrical energy by reducing the consumption of electrical power energy of the street lighting networks by applying different systems. First, MEW has changed mostly all the street lighting networks lamps from mercury lamps to high pressure sodium lamps which led to save approximately 33% of the electrical power consumption. Second, MEW has installed PLC system in some of their roads. And finally, MEW has applied power reduction system using street lights dual power dimming type to the majority of their street lighting networks. In this study, we will introduce the effect of the replacement of mercury lamps with high pressure sodium lamps, PLC installation, and the power reduction system using street lights dual power dimming type on the street lighting networks in the State of Kuwait in details.

II. The effect of changing mercury lamps with high pressure sodium lamps on the street lighting networks power consumption:

Ministry of Electricity and Water in the State of Kuwait (MEW) has taken a great step toward replacing mercury lamps with high pressure sodium lamps in the street lighting networks. The replacement of the mercury lamps to high pressure sodium lamps has almost completed in all street lighting networks, and the following table shows the

previous mercury lamp with its equivalent replacement current high pressure sodium lamp:

Mercury Lamp	High Pressure Sodium Lamp
6 Lamps x 400W (16m Lamp Posts)	4 Lamps x 400W (16m Lamp Posts)
400W	250W
250W	150W
4 Lamps x 1000W (22m Lamp Posts)	6 Lamps x 400W (22m Lamp Posts)

It is clear from the table above that for the high ways the replacement of mercury lamps with high pressure sodium lamps has been made by two methods:

1. For 16m lamps posts: reducing the number of the lamps from 6 to 4, and keeping the same power consumption of each lamp. As a result, for each 16m lamp post the total power consumption reduced from 2400W to 1600W.
2. For 22m lamp posts: increasing the number of the lamps from 4 to 6, and reducing the power consumption of each lamp from 1000W to 400W. As a result, for each 22m lamp post the total power consumption reduced from 4000W to 2400W.

For the downtown and residential areas the replacement was directly done by replacing all 400W and 250W mercury lamps with 250W and 150W high pressure sodium lamp respectively.

These changes or replacements from mercury lamps to high pressure sodium lamps did not affect the quality of lighting in the streets and roads.

III. PLC system in the street lighting networks:

Ministry of Electricity and Water in the State of Kuwait (MEW) have decided to use the Program Logic Controller (PLC) system in the street lighting networks in order to reduce the power consumption. They have used PLC system in three main roads, away from the city of Kuwait, with less crowded users at night. These roads called; Kabbd road, Alabdaly road, and Alsabeya road. The philosophy of PLC system is to turn off half of the streets lamps at midnight to reduce the power consumption of the lighting. Since the streets are not crowded after midnight then minimizing the illumination can be used as a technique to reduce the power consumption. In order to use all lamps in the street equally while turning off half of the lamps at midnight, then LPC is used, which is programmed to turn off half of the lamps at midnight and then in the next night the other lamps will be turned off instead of the lamps turned off previously. So, we will have two groups of lamps, group A and group B, group A will turn off at midnight in the first night then group B will turn off at midnight of the second night and so on. In each lighting post we have two lamps of group A and two lamps of group B, so at midnight each lighting post will reduce its illumination to the half.

PLC system has disadvantages which mainly concentrate on the illumination level in the streets and if it is sufficient for the street users or not. In some areas in the world such as in the western part of the world there are organizations and associations of public utility moved against the reduction of the illuminations in the streets at midnight, because it is a risk for the drivers to drive in such conditions. Therefore, MEW have used PLC system in three roads only and with very few street users on these roads to make sure that the reduction of the illumination will not cause any problem or risk drivers life.

In addition, in order to install PLC system to an existing street networks needs to reorganize the street light cables. Since PLC system needs to have two

groups of lamps then two cables should be installed instead of one cable in the normal street light networks. And because the street lighting networks in Kuwait is an old installation then drilling new cable channels is needed, which means additional cost.

By applying the PLC system we can get up to 25% of the power consumption saved. For example, if the road is 20 KM and we have lighting post each 50 m, and each post has 4 lamps (two lamps group A and the other two lamps group B), that means we will have 400 lighting posts, and 1600 lamps in both groups. If the operating time for the street lights is from 6:00 pm to 6:00 am, and one of the groups will turn off at midnight (12:00 am), then we will have the following:

800 lamps on for 12 hours

800 lamps on for 6 hours

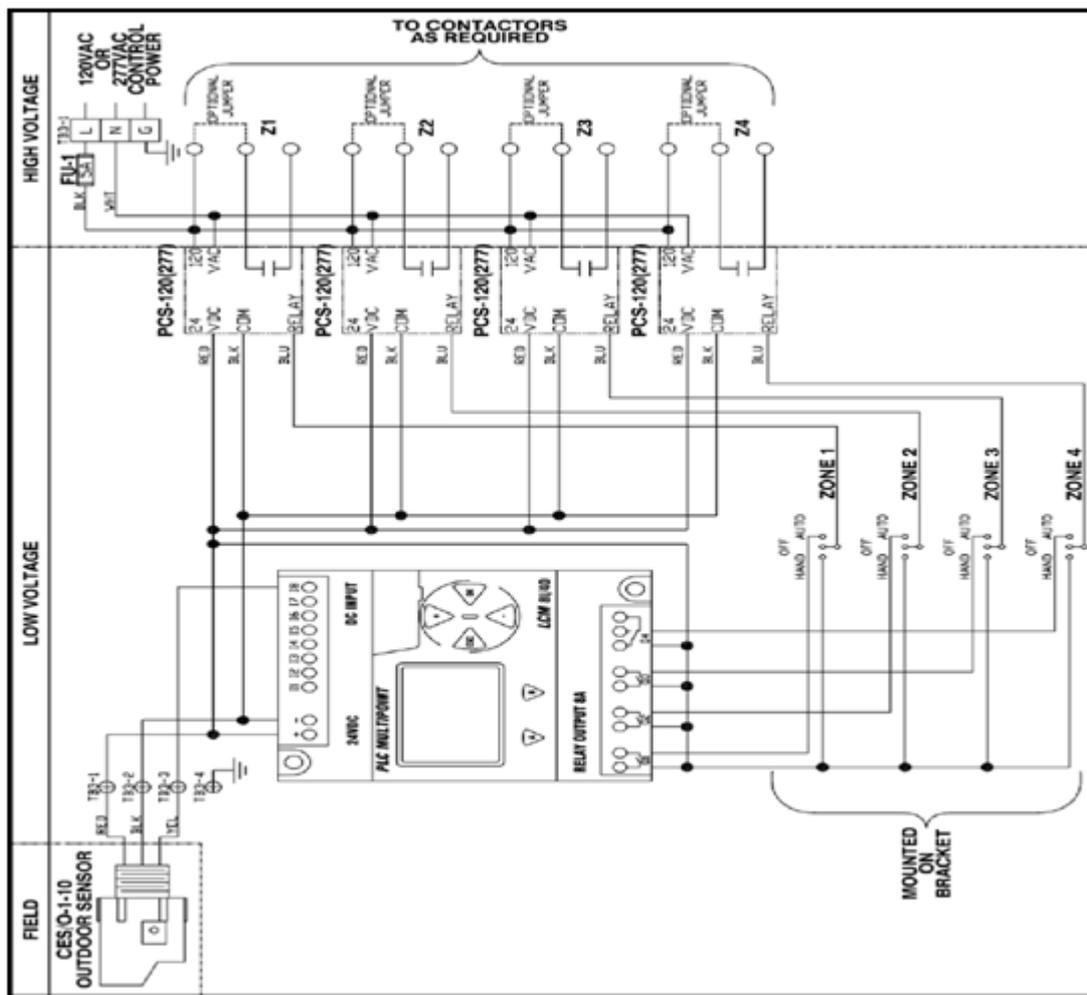
This is as we have 1200 lamps operating for 12 hours, and without using PLC system we will have 1600 lamps operating for 12 hours, so the reduction will be 25% of the total lamps.

This is assuming that the operating hours are equal before and after midnight, that is why we say approximately 25% taking in our consideration that the operating time of the lamps vary during the year.

Finally, beside the power consumption of the electrical energy we also have minimized the operating daily hours for the lamps, which means that the life time of the lamps is increased.

PLC wiring diagram is shown below:

This is a general wiring diagram for any PLC system. The diagram shows the principle of the operating circuit which can be programmed according to the needs. In our case the operating circuit does the changing (switching on and off) between the lamps of group A and the lamps of group B. In the circuit PLC device will give the set of contactors (either contactors for group A or group B) the order to switch off in the midnight, and in the next night PLC device will give the other set of contactors the order to switch off in the midnight and so on.



PLC Wiring Diagram

IV. Power reduction system using street lights dual power dimming type in the street lighting networks:

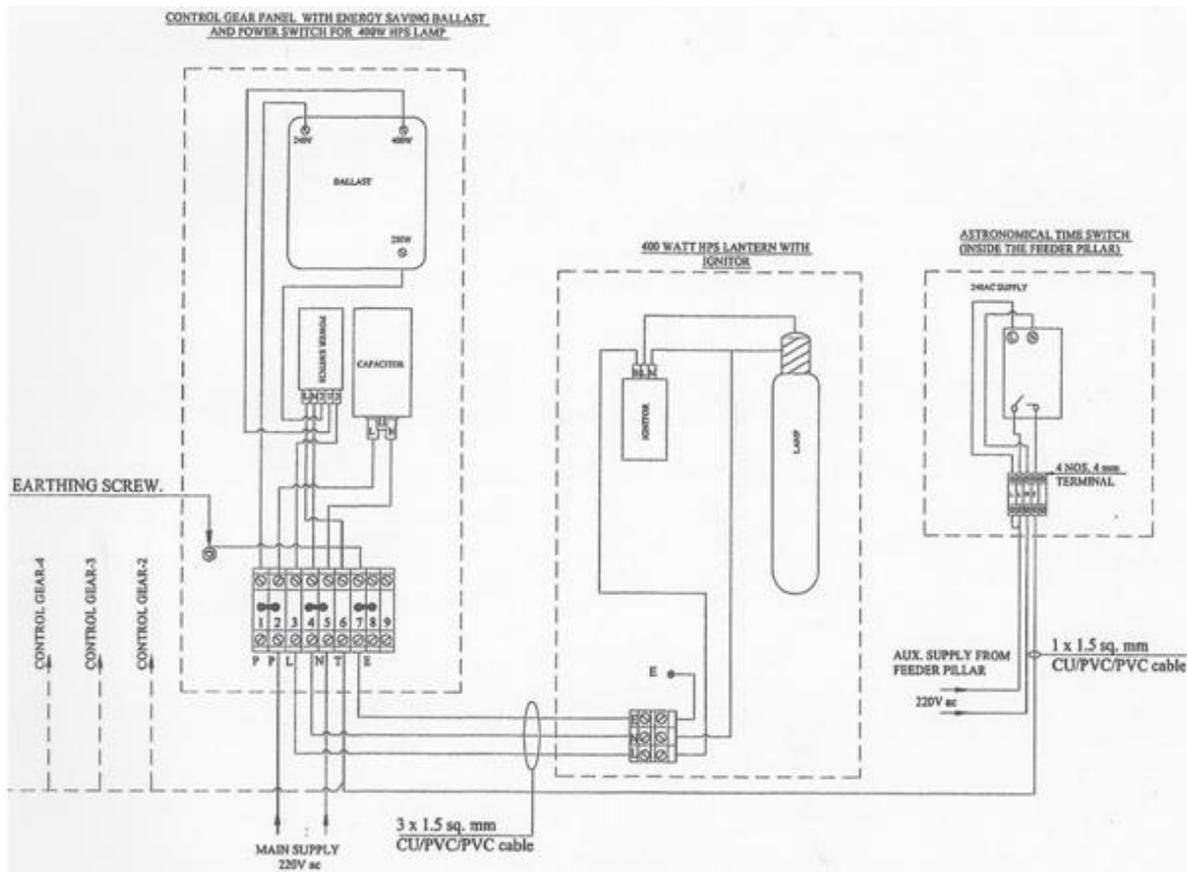
MEW has used power reduction system using street lights dual power dimming type in the street lighting networks in some of major residential areas in the State of Kuwait such as; Sabah Alsalem, Bayan, Mushrif, Aljabreya, Alferdous, Alardheya. In addition, MEW has decided to install street lights dual power dimming type in all new established residential area. The concept of this system is to reduce lighting after five operating hours to 60% of its full lighting in some cases and after seven operating hours to 60% of its full lighting. That means around midnight the lighting will be reduced by 40% and the illumination will be evenly distributed in all areas even after the reduction. In another words, street lights dual power dimming type will save the electrical energy by following:

If we assume the power of the lights is 100W, and operating hours are 12hrs, then the power consumption will be $100 \times 12 = 1200$ WHRS,

While by using street lights dual power dimming type system (if we assume the average operating hours of full light will be six hours) then the power consumption will be $100 \times 6 + 60 \times 6 = 960$ WHRS,

That means by using the above system we will save up to 20% of the electrical power consumption.

Therefore, as an advantage of using this system is to have homogenous and well distributed illumination in the streets, and to save the electrical energy by 20% approximately. But on the other hands, there are some disadvantages as well such as; when the illumination of the lamps is reduced the risk of the roads safety will be high. Also, there is a technical disadvantage of this system when you have one or more of the dimmers out of order, because this will be very difficult to observed and not easy to discover and locate.



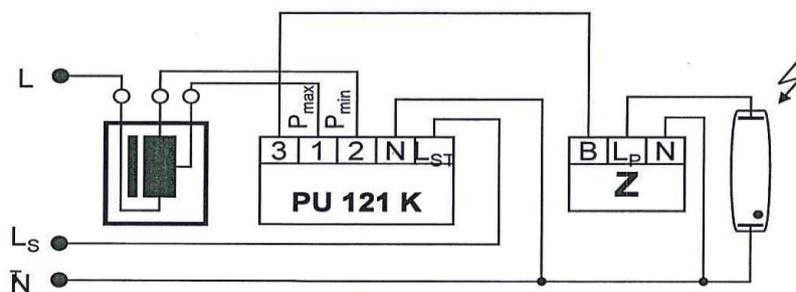
Wiring Diagram for Dimming with Energy Saving Ballast

V. Electrical power energy saving in the street lighting networks:

As we have demonstrated above, MEW has placed different systems and steps toward saving electrical energy by reducing the power consumption of the street lighting networks. The changing of streets lamps from mercury type to high pressure sodium type looks the better step of reducing electrical power consumption in the street lighting networks within the State of Kuwait. Although, the other steps have good effect of reducing electrical power consumption as well. MEW is working very hard to get the street lighting networks of high

efficiency at the lowest cost by reducing the electrical power consumption.

As in the year of 2015, the street lighting networks power consumption in all governorates in the State of Kuwait is 110 MW approximately, and this amount is after several steps of power reduction and electrical energy saving. In addition, replacing high pressure sodium lamps in the street lighting networks by LED (light-emitting diode) lamps is the new project which is under study in MEW. According to MEW sources, the electrical energy saving in the street lighting networks could be around 50% by replacing high pressure sodium lamps with LED lamps.



Power Reduction – Power Switch PU 121K used in Kuwait Street Lighting

Finally, MEW is studying the possibility of installing solar power energy for the street lighting networks, by installing a new street light posts with its own solar power energy production, but it looks very expensive for the time being and the project can be considered as under study one.

VI. Conclusion

Saving energy is a target of all countries over the world, and in this case study we have introduced the intention of the Kuwaiti government through (MEW) of saving the electrical energy by applying different systems in the street lighting networks. That could be followed and used as an ideal situation for other countries, also can be still developed to another level of saving energy. In addition, the other countries over the world are trying to reduce the consumption of electrical energy by applying different systems and methods in their street lighting networks which can be useful to be applied in the State of Kuwait. As a result, countries can exchange experiences between them for saving energy.

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