Presentation of the inductive electronic ballast

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ABSTRACT

This paper describes the technology behind inductive electronic ballasts used to run high-pressure sodium lamps and metal-halide lamps. Inductive electronic ballasts replace traditional control gears to operate such lamps, and in doing so, it offers long-term energy savings and reduction of greenhouse gas emissions.

Inductive ballasts also enable electronic dimming, allowing to up to 60% reduction in energy consumption. The inductive ballast described in this paper has a power factor of 1.0 with nearly no electromagnetic pollution on networks. The ballast further provides galvanic insulation from the main. The risk of electric shocks is avoided and maintenance is reduced (no risk for general short circuit or earth leakage). Automatic regulation of the lamp feeding will maintain constant light output as well as longer lamp lifetime.

Two large outdoor lighting installations in France are already equipped with inductive electronic ballasts.

BACKGROUND

The inductive electronic ballast has been designed 7 years ago to run High Pressure Sodium and also Metal Halide lamps. It replaces the standard ferromagnetic control gear, which is traditionally used to run discharge lamps used for street lighting. Today, more than 18 000 lamp posts are run each night by this electronic system worldwide. We will speak later about our most significant references.

A street lighting network equipped with such inductive electronic ballasts offers a range of advantages that are technically and economically impossible to achieve with traditional power-feeding systems. The concerned public authority gets the warranty of a safety level towards street or road users that responds to all European requirements. This safety warranty is achieved both on electrical and on light output functions, thanks to the basic principle of electromagnetic induction.

This technological particularity allows the electronic ballast to equip new street lighting installations, but also to improve old installations, bringing them to current safety requirements. By this way, it can be much more useful and easy to replace only the feeding system of an old street lighting network, rather than changing the whole equipment: changing a steel pole that could last some more 10 years and its individual lantern would cost much more than replacing only the old and sometimes dangerous control gear by a totally safe electronic ballast.

Equipping a street lighting network with inductive electronic ballasts offers 4 major advantages:

The first particularity concerns energy saving:

15% to 20% savings can be easily observed on an installation equipped with electronic ballasts in comparison with an installation equipped with the standard system.

3 reasons explain this difference of consumption:

- Electronic circuits use much less current for their own running in comparison with a traditional control gear, composed by the ballast, the capacitor and the ignitor.

The losses on such standard coils reach in average 15%. For a similar use and a similar lamp power, only 5% losses are measured on the electronic ballast. A proof of this better electrical efficiency consists in its ΔT, which remains at 25°C. This fact creates of course less heat losses into the atmosphere, contributing to reduce the greenhouse effect.

- Following this, the power factor of the electronic ballast is obtained without any compensation. It is therefore guaranteed over time. The subscribed power of the global installation can be reduced and is never exceeded. Losses are also reduced on the feeding lines.
- The last explanation of such a consumption difference is based on the fact that the electronic ballast regulates the power supplied to the lamp independently of Main's voltage fluctuations. Those voltage increases occur often during the night. In this case, the consumption of a standard control gear increases directly: a 150W High pressure Sodium lamp can consume until 205W if the Main's voltage goes from 230V until 245V. In this case, it is obvious that the light output of this standard control gear will also increase, but the result will be an over lighting: the light pollution will be obvious.

On the other hand, if the Main's voltage decreases from 230V until 220 or 210V, the consumption of the ferromagnetic control gear will directly decrease, as a consequence that the light output will also seriously decrease: in this case, the light level will be too low, which can be dangerous for road traffic.

Thanks to its automatic regulation of the lamp power, the inductive electronic ballast allows a constant consumption but also a constant light output. This offers the guarantee for road users to get a constant visual safety when they are driving. For street passers-by, a constant light level creates a safety feeling which maintain people in some areas and avoids to create empty places, which generates insecurity and vandalism.

The second characteristic concerns a flexible dimming facility

Each electronic ballast can be dimmed on 3 different levels: 75% power, 50% power or lamp switched off.

The dimming system of the electronic ballast offers a high level of flexibility. Indeed, each lamp post can be dimmed individually, according to its position in the street. For example, a crossroad can be illuminated at 100% during all the night, while some other lamp posts can be dimmed at 50% in some residential areas that are less visited at night.

The wished dimming period can be easily chosen on a clock mounted on a general dimming transmitter installed in the head cabinet of the lines. The dimming signal is sent directly on the Main.

Of course, the main interest of dimming is to make some more energy savings: if this dimming option is used, the electricity needs of an installation equipped with electronic ballasts can reach 50 to 60% less than for a standard street lighting installation.

Another reason for dimming is to avoid light pollution in the middle of the night: for example, 25% power reduction means about 50% less light. For all those reasons, the inductive electronic ballast is supported by the ADEME Agency for big installations.

The wide choice of dimming signals that are technically compatible with the inductive electronic ballast allows the user to find a satisfying solution for each network configuration. Finally, the standard dimming signal sent by the transmitter does not creates any electromagnetic pollution and does not disturb the feeding of other complementary urban equipment, like bus shelters or road indication panels.

The third advantage concerns the maintenance:

High-quality electronics chosen in the range of military-standard components is used for the circuits of the inductive electronic ballast. The main part of the unit is protected inside an IP65 plastic casing filled with an insulating resin, giving to the whole unit the Class II safety degree.

An important part of the maintenance cost of a street lighting equipment comes from the lamp. Big cities for example use to do systematic changes of lamps every 2 or 3 years. Thanks to its constant regulation of the lamp's feeding, the electronic ballast allows to increase considerably the life time of the lamp. A lamp fed with a constant power will logically last longer than a lamp victim of regular voltage increases which generates an obvious over consumption. Thus, its has been measured that a lamp fed with an inductive electronic ballast still produce 95% of its initial light output after 8500 hours, which corresponds roughly to a 2-years running time. On the same basis, a lamp fed with a standard ferromagnetic control gear produces around 10% less light after the same time.

We will study further on a realistic example of maintenance's costs saving allowed on lamps.

The fourth characteristic of the electronic ballast is based on its main technical characteristic: the electromagnetic induction

Indeed, the main part of the ballast is equipped internally with a real separation transformer: thus, there is a galvanic separation between the current coming from the Main and the current going to the lamp. The electricity transmission within the electronic ballast is made through induction. That means that a "floating potential" is created within the lamp post, because there is no more liaison to earth. This particularity offers a significant advantage both for people and technicians regarding electrical safety: in fact, that means that there is no more risk of electrocution by touching a badly insulated lighting column that would be in contact with an internal wire of the lamp circuit.

The second advantage of this physical separation between Main and lamp circuits concerns the maintenance: in case of a short-circuit, the lamp switches off, but re-ignites naturally once the short-circuit is over. Such a short-circuit can no longer be transmitted to all the street lighting line, which would in such a case plunging the whole neighbourhood into darkness. Failure of the entire street lighting lines are sometimes created on purpose by drug dealers or thieves in order to handle quietly. Such vandalism acts can no longer happen with inductive electronic ballasts, who guarantee permanent lighting for traffic and pedestrian areas.

This electronic feeding system is not anymore a prototype: more than 300 cities and various areas are equipped worldwide since 1997. The biggest part of those references are located in France and its Overseas Territories. European countries like Belgium, The Netherlands or Switzerland have already tested the system. The 2 most prestigious references in France are two airports: the Paris-Orly airport, equipped with around 200 units, and the "Pôle Caraïbes" airport of the Guadeloupe Island in the French West Indies, with about 300 units. Both have chosen the system for its impact on their global electricity bill, but also for its performances regarding its low electromagnetic pollution rate, compared with a standard system.

Other prestigious references are given by European capitals like The Hague in Holland or Brussels in Belgium. The main interest for those two cities were energy saving, reduction of light pollution and guarantee of permanent light in unsafe areas.

Finally, Infrastructure Ministries and Roadways Administrations like "Rijkswaterstaat" in Holland have equipped several installations for the flexibility of its dimming system allowing a minimum light level for late night drivers, and for the ease of lamps' maintenance allowed by the electronic ballast.

Return on investment for a street lighting installation equipped with inductive electronic ballasts
Example for 50 lamp posts 150W HPS

Control gears' purchase (Costs in Euros)

Ferromagnetic ballast + ignitor + capacitors + Class II protection box	
(IP44, Class II) =	129 Euro
x 50 units =	6578 Euro
Cost of a traditional feeding system	6578 Euro
Inductive electronic ballast (IP 65, Class II) =	300 Euro
x50 units =	15 000 Euro
Dimming order transmitter 20A three phased	
x1 unit =	526 Euro
Total cost of an electronic feeding system with dimming option	15526 Euro

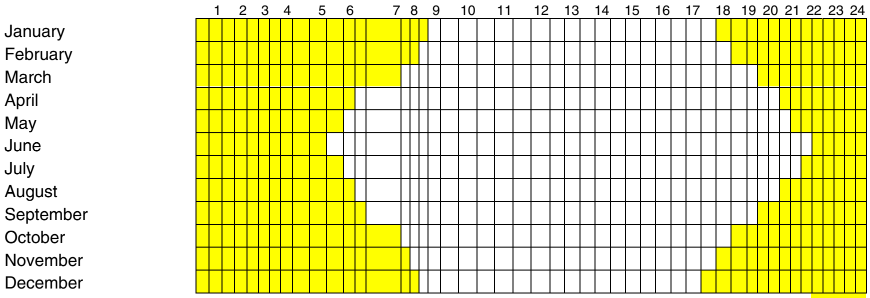
Conclusion:

Over cost for an electronic feeding system 8948 Euro

Electricity budget

Running time of the lamps
With traditional feeding

Period by 100%

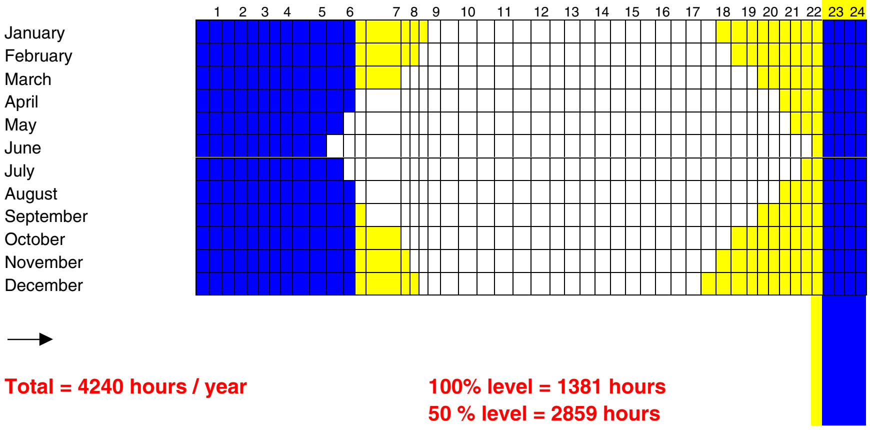


Total = 4 240 hours / year

With the electronic feeding + dimming function

Period by 100% Dimming period

Chosen dimming level 50%



Total = 4240 hours / year

100% level = 1381 hours
50 % level = 2859 hours

Electricity price

Electricity supplier : E.D.F.

Used prices : “Blue price-list for long use in public lighting (Code 071)

Price of the KVA (Kilo Volt Amp) = 92,18 Euro

Price of the KWH (Kilowatt hour) = 0,04 Euro

Average night voltage on Main’s supply = 242 V

Consumption with ferromagnetic control gear

Consumption of each lamp post (242V) = 200W

Global power = Number of lamp posts x Consumption per unit = 50 x 200W = 10 KW

Subscribed power = Global power / power factor (average power factor = 0,7)

= 10 KW / 0,7 = 14,3 Kilo Volt Amps (KVA)

Subscription for 1 year = Subscribed power x Price of the KVA

= 14,3 KVA x 92,18 = 1318,17 Euro

Cost of the consumption for 1 year = Global power x Number of hours x Price of the KW/hour

= 10 KW x 4240 x 0,04Euro = 1696 Euro

Yearly electricity budget = Subscription + Cost of consumption

= 1318,17 Euro + 1696 Euro = 3014,17 Euro

Consumption with the inductive electronic ballast

Consumption of each lamp post (242V)= 160W (by 100% running)
80 W (by 50% dimming)

Global power = Number of lamp posts x Consumption per unit

Global power by 100% running = 50 x 160W = 8 KW

Global power by 50% dimming = 50 x 80W = 4 KW

Subscribed power = Global power by 100% running / power factor (power factor = 0,98)

= 8 KW / 0,98 = 8,1 Kilo Volt Amps (KVA)

Subscription for 1 year = Subscribed power x Price of the KVA

= 8,1 KVA x 92,18 = 746,66 Euro

Cost of the consumption for 1 year = Global power x Number of hours x Price of the KW/hour

Cost of the consumption for 1 year by 100% running = 8 KW x 1381 x 0,04 Euro = 442 Euro

Cost of the consumption for 1 year by 50% dimming = 4 KW x 2859 x 0,04 Euro = 457,5 Euro

Yearly electricity cost = Subscription + Cost of consumption by 100% running + Cost of consumption by 50% dimming

Yearly electricity cost = 746,66 Euro + 442 Euro + 457,5 Euro = 1646,2 Euro

Conclusion

Total cost saving on the electricity bill of this installation equipped by inductive electronic ballasts dimmed to 50% from 10:00pm to 06:00am

= Yearly budget of the installation with traditional systems – Yearly budget of the installation with inductive electronic systems

= 3014,17 Euro - 1646,2 Euro

= 1368 Euro

Maintenance cost of the lamps

Systematic change of all the lamps

The power regulation function of the inductive electronic ballast increases the economic life time of the lamps, because it preserves them from over-running due to Main’s voltage variations.

Thus, a global relamping can be organized every 3 years, instead of every 2 years.

Cost of a global relamping operation = 40 Euro per lamp

Saving made thanks to the electronic ballast = (40 / 2) – (40 / 3) = 20 – 13 = 7 Euro per year

Yearly saving on the complete installation

= 7 x 50 = 350 Euro

Conclusion

Return on investment for a street lighting installation equipped with 50 inductive electronic ballasts:

YEARLY ENERGY SAVING	1368 Euro
YEARLY SAVING FOR THE LAMPS’ MAINTENANCE	350 Euro
YEARLY TOTAL SAVING WITH INDUXI	1718 Euro
RETURN ON INVESTMENT	**8948 / 1718** Euro
5 YEARS 2 MONTHS	

OBSERVATIONS

THIS RETURN ON INVESTMENT CALCULATION DOES ONLY TAKE INTO ACCOUNT THE ENERGY SAVINGS AND THE LAMPS MAINTENANCE SAVINGS.

DO NOT FORGET THE OTHER EXISTING MAINTENANCE COSTS SAVINGS MADE WITH INDUXI ! YOUR RETURN ON INVESTMENT CAN BECOME SHORTER !

THEY ARE QUITE SIGNIFICANT AS WELL AND GIVE YOU A GOOD IDEA ABOUT THE RELIABILITY OF THE INDUXI SYSTEM.

ASK YOUR CUSTOMERS HOW MUCH DO FOLLOWING OPERATIONS COST THEM:

	Ferromagnetic gear	INDUXI
Change of the ballast	10 / 15 years	20 years
Change of the ignitor	3 / 4 years	20 years
Change of the capacitors (to preserve a correct cosφ)	4 / 5 years	20 years
Maintenance of earth circuit	?	No earth leakage current
Bad connection inside the control gear	Purchase of a new control gear	No risk of bad connection
Corrosion of the control gear (connections)	Purchase of a new control gear	No risk of corrosion (IP65 Cl. II)
Short-circuit on the lamp's cables	Time to find the failure + repair	No risk of short-circuit
Change of the luminary	A Class II luminaire may be required	No need of Class II luminaires
Lamp at end of life	The lamp blinks: time to find what is the problem for the maintenance team	Led light that indicates what is wrong
SAFETY *What is the price of safety?*	Purchase of one supple - mentary earth leakage switch for each pole	**Total safety included**