

PHISICALLY-BASED MODELLING OF INDUCTION LAMPS: APPLICATION TO THE IMPROVEMENT OF ENERGY EFFICIENCY IN THE LIGHTING SYSTEM OF A UNIVERSITY BUILDING



Antonio Gabaldón Marín, Member IEEE, Universidad Politécnica de Cartagena (UPCT), SPAIN

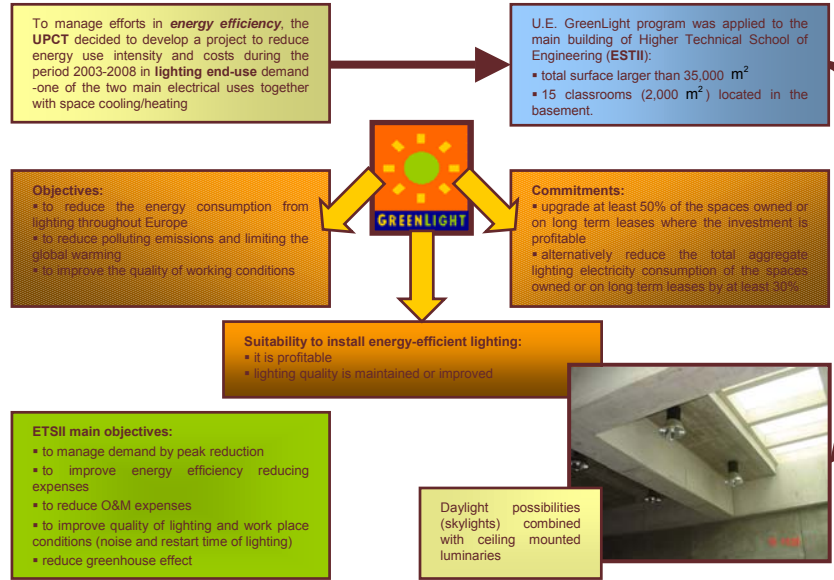
Fernando Sequera Ballesteros, UPCT, SPAIN
 Ángel Molina García, UPCT, SPAIN
 Emilio Gómez Lázaro, UPCT, SPAIN



Francisco J. García Franco, Universidad Politécnica de Valencia (UPV), SPAIN
 Nuria Encinas Redondo, UPV, SPAIN



Sergio Valero Verdú, Universidad Miguel Hernández (UMH), SPAIN
 Mario Ortiz García, UMH, SPAIN



BASELINE

20*150 W High Intensity discharge lamps - metal halide- (HID) with magnetic ballast.

Drawbacks:

- excessive heating of luminary (low lifetime)
- audible noise (magnetic ballast)
- restarting periods (up to 240 seconds) ► difficulty for the teaching activity

Mesures

Parameter	PR-14	PR-15
Average illuminance level (lm)	820	850
Rated Power (without ballast)	2 kW (1)	3A/W (1)
Average power demand (inc. ballast)	2.53 kW	2.61 kW
Average power factor (inc. ballast)	0.7911	0.7544

(1) 20*150W HID lamps

Tasks -field test in classrooms:-

- monitoring the overall demand and harmonics in LV lines
- retrofit: magnetic ballasts ► **electronic ballast**
- retrofit: 150W HID ► 165W Induction lamps
- to asses benefits and impacts of alternatives

Alternatives

- To change to new fluorescent luminaries (too expensive)
- The use of **electronic ballasts** (most promising)

The retrofiting of lighting with a new technology - induction lamps + high frequency equipment-

Tasks -laboratory test:-

- switch On and OFF duty cycles of induction lamps (illuminance, power & bulb temperature)

Low consumptions rates

Main tests results: Economical

Cost	Class. PR-14	Class. PR-15
Cost	1.6	2.96
Equivalent	0.23	0.04
O&M (cost)	0.23	0.04
Energy (cost)	0.41	0.14

Power & illumination HID & induction

Parameter	Class. PR-14	Class. PR-15
Average illuminance level (lm)	925	550
Rated Power (lamp)	2.4 kW (1)	2.6 kW (1)
Average power	2.06 kW	1.67 kW
Average power demand (inc. ballast)	0.9%	0.6%

EMC & quality of supply

Parameter (%)	Class. PR-14	Class. PR-15
THD (%)	0.01	0.01
THF (%)	0.01	0.01
THG (%)	0.01	0.01
THD (%)	0.01	0.01
THF (%)	0.01	0.01
THG (%)	0.01	0.01

(1) HID conventional ballast (2) New ballast for each technology

INDUCTION LAMPS SINUSOIDAL CURVE

ELECTRONIC BALLAST:

- high noise level
- high restart time (up to 180 s)
- reliability problems

LOW TEMPERATURES

FINAL SOLUTION ► INDUCTION LAMPS + HIGH FREQUENCY EQUIPMENT

INDUCTION LAMPS

- combines basic principles of electromagnetism and gas discharge
- no filament or electrodes in the light bulb
- average power demand: 65% of expected

Others:

- excellent colour rendering
- flickers free
- instant restart (cold or heat)
- efficacy 5 times higher than incandescent (12,000 lumens with 165 W lamp)

O&M expenses reduction: lifetime 4 times higher than HID lamps

RETROFITTING:

- 150 W HID ► 165 W induction lamps (same luminaries)
- 16 lamps / classroom
- 16 classrooms

Benefits:

- 35 kW peak demand reduction (3-5% overall demand)
- Good illuminance level (DIN 5035, IEC8995)
- Harmonics reduction (transformer K factor reduction from 3.58 to 1.25) ► **unload transformer**