

Effects of LED driver efficiency and output current accuracy improvement

This document presents a detailed analysis of how LED driver improvements in electrical efficiency and output current accuracy impact luminaire performance, energy consumption, thermal behavior, and system-level cost. Numerical examples use typical luminaire values.

ELECTRICAL EFFICIENCY IMPROVEMENT (EXAMPLE: FROM 93% TO 95%)

Improving driver efficiency reduces input power, energy consumption, and thermal losses. The example assumes constant LED output power of 80 W.

Input Power:

- At 93% efficiency: $80 / 0,93 = 86.0 \text{ W}$
- At 95% efficiency: $80 / 0,95 = 84.2 \text{ W}$

Power saved: 1.8 W per luminaire

Lifetime Energy Savings:

Assuming 100,000 h lifetime:

$1.8 \text{ W} \times 100,000 \text{ h} = 180 \text{ kWh}$ saved per luminaire.

Thermal Impact:

Driver losses:

- 93% efficiency: 6.0 W
- 95% efficiency: 4.2 W

-> **30% reduction** in internal losses, reducing component temperatures and improving lifetime.

OUTPUT CURRENT ACCURACY ($\pm 5\%$, $\pm 3\%$, $\pm 2\%$)

Output current accuracy determines output current variation of LED driver and thus luminaire lumen output variation from unit to unit. Assuming flux is proportional to current, a 1000 mA, 10,000 lm luminaire produces the range of luminous flux calculated below.

Flux Variation:

- $\pm 5\%$ accuracy -> 950–1050 mA -> 9,500–10,500 lm (1,000 lm spread)
- $\pm 3\%$ accuracy -> 970–1030 mA -> 9,700–10,300 lm (600 lm spread)
- $\pm 2\%$ accuracy -> 980–1020 mA -> 9,800–10,200 lm (400 lm spread)

Uniformity improvement: From $\pm 5\%$ to $\pm 2\%$ reduces flux spread by **60 %**.

ENERGY IMPACT OF ACCURACY-DRIVEN OVERDRIVE

To guarantee that every luminaire meets a minimum of 10,000 lm, nominal current must be set so the lowest-tolerance unit still delivers 1000 mA equivalent output.

Required Set Current:

- $\pm 5\%$ driver: $1000 / 0.95 = 1053$ mA
- $\pm 3\%$ driver: $1000 / 0.97 = 1031$ mA
- $\pm 2\%$ driver: $1000 / 0.98 = 1020$ mA

Lower accuracy forces permanent overdrive, increasing power and heat.

LED Output Power:

(Base 80 W at 1000 mA)

- $\pm 5\%$ -> 84.2 W
- $\pm 3\%$ -> 82.5 W
- $\pm 2\%$ -> 81.6 W

Overdrive penalty:

- $\pm 5\%$ vs $\pm 2\%$ -> +2.6 W
- $\pm 3\%$ vs $\pm 2\%$ -> +0.9 W

Lifetime Energy Waste (100,000 h):

- $\pm 5\%$ vs $\pm 2\%$ -> 260 kWh
- $\pm 3\%$ vs $\pm 2\%$ -> 90 kWh

COMBINED SYSTEM-LEVEL BENEFITS

- Efficiency improvement: **180 kWh saved per luminaire**
- Accuracy improvement: **up to 260 kWh additional savings**
- Total: **up to ~440 kWh per luminaire**

- Reduced thermal stress on driver and LEDs
- Improved lumen maintenance and lifetime
- Higher uniformity of lumen output
- Lower operating cost and reduced overdesign

Improving LED driver efficiency and output current accuracy provides measurable engineering, financial, and performance benefits. Even small improvements compound significantly over tens of thousands of operating hours and large-scale installations.