Energy Efficiency in industrial Lighting Systems

Lighting systems represent a significant portion of energy consumption in manufacturing facilities, often accounting for 10-20% of total electrical usage. Understanding how to optimize these systems can lead to substantial cost savings and improved operational efficiency. The energy consumption of any lighting system follows a fundamental equation:

$$kWh_{lighting} = \frac{lumens}{\left(\frac{lumens}{Watt}\right) * 1000} * hours$$

Lumens = amount of light output
*Lumens / kW = **efficacy,** or ratio of light output to electrical power input*
Hours = hours of time the light is on

This formula reveals three key areas where energy savings can be achieved; 1) Decrease light output, 2) Increase efficacy, and 3) Decrease burn hours.

Decreasing Lumen Output Through Right-Sizing

The first approach to energy savings involves ensuring your facility isn't over-lit. Every manufacturing space has recommended illumination levels measured in footcandles (lumens per square foot). Conducting a comprehensive lighting audit with light meters will reveal whether your current system exceeds these requirements. The table below shows some generic footcandle recommendations based on space type. In practice, qualitative input from the workers is more important that the footcandle reading on the floor, so it is recommended to get as much qualitative feedback as quantitative measurement during the lighting survey.

Space Type	Recommended Footcandles	Notes
General Manufacturing/Assembly	30-50	Medium detail work
Precision Manufacturing	100-200	Fine detail, quality control
Machine Shops	50-100	Varies by operation complexity
Welding Areas	50-100	Task-specific supplemental lighting often needed
Material Handling/Warehousing	10-30	Aisles and general storage
Loading Docks	20-50	Safety-critical area

Space Type	Recommended Footcandles	Notes
Offices (Manufacturing)	30-50	Computer work and paperwork
Conference Rooms	30-50	Meeting and presentation activities
Break Rooms/Cafeterias	20-30	Casual dining and socializing
Restrooms	10-30	Basic visibility and safety
Corridors and Hallways	5-20	Navigation and safety
Stairways	20-50	Safety-critical transitions
Emergency Exits	10-20	Code-required minimum levels
Quality Control/Inspection	100-500	Depends on inspection detail required
Paint Booths	100-200	Color matching requirements
Electrical Rooms	30-50	Equipment maintenance access

De-lamping represents the simplest initial approach. In fluorescent tube fixtures, removing every second or third lamp can significantly reduce energy consumption while maintaining adequate lighting levels. This strategy works particularly well in areas with high ceiling heights where light levels often exceed requirements.

Fixture replacement offers a more permanent solution when existing lighting substantially exceeds recommended levels. Installing lower-wattage fixtures designed for your specific application ensures optimal light distribution while reducing energy consumption.

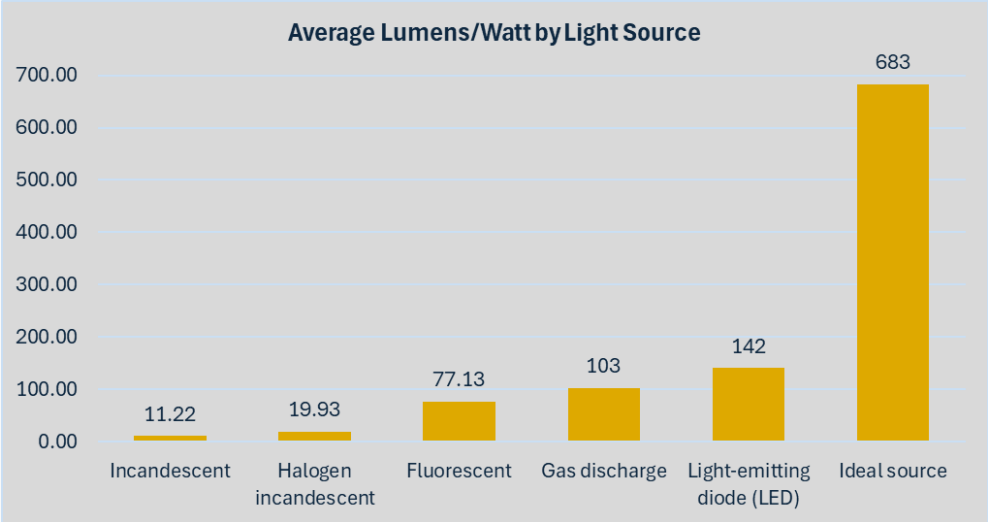
Dimming systems provide the most flexible approach to lumen reduction. Modern dimming controls allow for precise adjustment of light levels throughout the day or based on specific operational needs. Advanced systems can integrate occupancy detection, automatically reducing light output in unoccupied areas rather than switching lights off completely, which helps extend lamp life.

Maximizing Lighting Efficacy Through LED Conversion

Efficacy, measured in lumens per watt, represents how efficiently a lighting system converts electrical energy into visible light. Light Emitting Diode (LED) technology offers superior efficacy compared to traditional lighting technologies including fluorescent, incandescent, metal halide, and high-pressure

sodium systems. LED light efficacy varies by lamp/fixture type and the generation of LED chip. In general, LED's often output >130 lumens/watt and up to 185+ LM/watt for certain fixture types.

Comparison of LED efficacy to other light sources



The transition to LED lighting represents the most impactful single improvement for most manufacturing facilities. While the concept of retrofitting all lighting to LED'S is simple, the specification process requires careful consideration of several factors to ensure optimal performance and compatibility. When specifying LED retrofits, you must consider the replacement's wiring specifications, fixture mounting methods, socket compatibility, dimming compatibility, dimensional constraints of existing housings, beam angle output, and other characteristics that can cause problems when trying to install the new material. I know firsthand how easy it is to order LED material that is slightly incompatible and forces you to rethink the entire solution.

Minimizing Burn Hours Through Smart Controls

Reducing operating hours represents the third pillar of lighting energy efficiency. While manual switching sounds straightforward, human behavior is unreliable compared to automated controls.

Occupancy sensors provide automated control, ensuring lights operate only when spaces are occupied. In office areas, wall-switch integrated sensors offer simple installation and operation. Manufacturing spaces typically require ceiling-mounted sensors or fixture-integrated options that can handle larger detection zones and industrial environmental conditions.

Advanced occupancy sensing systems can differentiate between different types of movement and adjust accordingly, preventing false triggers from equipment vibration while reliably detecting human presence. Some systems incorporate daylight harvesting capabilities, automatically dimming artificial lighting when sufficient natural light is available.

Implementation Strategy

A systematic approach to lighting energy efficiency begins with a comprehensive audit to establish baseline energy consumption and identify opportunities. In my opinion, it is best to use a lighting auditor who is equipment agnostic and is looking to find the solution that is best for your facility.

Ideally, you should aim to install LED's throughout the facility as part of one project. If the entire project cannot be funded all at once, priority should be given to areas with the highest operating hours and greatest over-illumination. Consider the interplay between all three energy reduction strategies rather than implementing them in isolation.

Always check if your utility company offers rebates for LED conversions and advanced control systems, further improving project economics. While LED rebates are not as common as they once were, they still exist and are worth investigating.

Final Thoughts

Proper implementation of these lighting efficiency strategies can reduce lighting energy consumption by 50-80% while maintaining or improving illumination quality throughout your manufacturing facility. Unfortunately, it is not as easy as buying a few pallets of one size fits all LED fixtures and installing them around the facility. There is a necessary lighting audit and material selection process that must take place first. If you need help or have any questions about getting your facility's lighting energy optimized, contact Efficiency Hub at info@efficiencyhub.net.