

Lighting Systems Energy Auditing Guidebook

1. Introduction

Lighting systems are critical support systems in facilities such as flower farms, factories, Godowns, commercial buildings, and educational institutions. Appropriate lighting directly influences productivity, product quality, occupational safety, energy consumption, and maintenance costs.

In many lighting intense facilities, the energy consumed by lights may account for more than 10%. Poor lighting design, improper control configuration, or inadequate maintenance may result in over-illumination, under-illumination, poor power quality and high operational and maintenance costs. A lighting system audit is useful in solving these problems.

An effective audit of lighting system evaluates the entire lighting pathway from the distribution panel, control systems and luminaires to the illuminated task areas. This integrated approach ensures that inefficiencies are identified at every stage, including: excessive installed capacity; improper illuminance levels; ineffective controls; power quality issues; and maintenance-related lumen depreciation. The outcome provides a foundation for targeted technical improvements and informed financial decision-making.

In this chapter, the guidebook provides a structured, step-by-step approach that the energy auditor can use to identify lighting system inefficiencies, quantify their magnitude, and recommend appropriate interventions. The audit framework focuses on:

- a) Supply–demand (illuminance) matching
- b) Lighting retrofit evaluation

- c) Design and maintenance assessment
- d) Energy performance analysis
- e) Quantification of energy and financial savings

Lighting fixtures should meet the recommended lux levels. These levels are different depending on the activity undertaken under the light. For example, the lighting levels for sleeping hotel rooms are different from a flower farm packhouses. These levels can be referenced from illuminance recommendations are based on internationally recognized guidelines such as those from the International Commission on Illumination (CIE) and the Illuminating Engineering Society (IES). Apart from these, the organizations can set their standard levels and it is advisable for the auditor to find out if such customized standards exist and apply them in the supply – demand matching analysis.

Effective auditing of the lighting system begins by understanding the components of the system.

2. Components of a Lighting System

Components of a lighting system in a facility can be categorized into three sections as illustrated in figure 1.

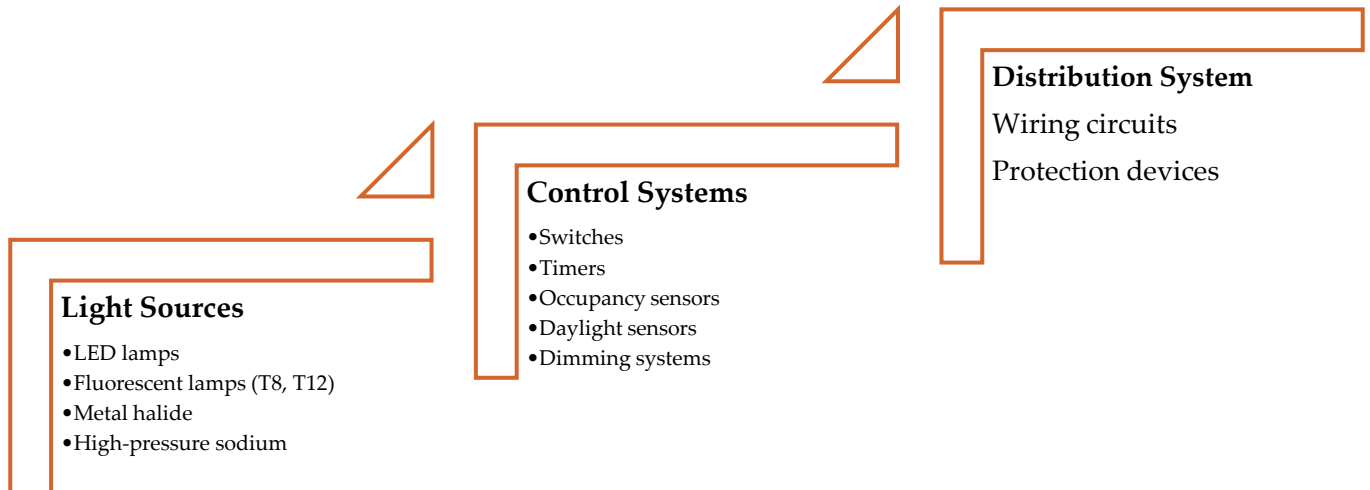


Figure 1 Components of a lighting system

A whole system audit should consider all the components as illustrated in figure 1 and their functions.

Light Sources

A facility can derive illumination from different lighting sources and luminaire configurations depending on operational requirements, environmental conditions, and energy management strategy. These typically include natural daylighting, electrically powered artificial lighting systems, and emergency or backup lighting systems. It is important for the auditor to establish the contribution of each source, their configuration, and control hierarchy. In some facilities, lighting systems operate in hybrid mode where daylight is prioritized through daylight harvesting controls, and artificial lighting supplements the deficit as required.

Control Systems

Lighting control systems regulate when, where, and at what output level luminaires operate within a facility. Their role is to align lighting supply with actual demand.

During an energy audit, it is important to establish the type of control systems installed, their configuration, zoning arrangement, override capability, and integration with building operations.

In many facilities, lighting inefficiencies arise not from poor luminaire selection but from inadequate or improperly configured controls. Some of the lighting controls that the facilities use include:

- | | |
|-------------------|---|
| Switches | These may be individual point switches, multi-way switching systems, or centralized distribution board controls. The auditor should determine whether switching is properly zoned according to functional areas like production lines, offices, corridors, or if large areas are controlled by a single switch, leading to unnecessary lighting during partial occupancy. Poor partitioning often results in over-lighting and wasted energy |
| Timers | They are used where lighting operation follows predictable schedules, such as security lighting, signage, parking areas, or exterior floodlighting. Timers may be mechanical or digital and can be programmed for daily or weekly cycles. The auditor should verify that timer schedules reflect actual operational hours and seasonal variations. Mismatched timing settings often lead to lights operating during daylight hours or non-operational periods |
| Occupancy sensors | These are commonly applied in offices, classrooms, washrooms, stores, and corridors. Sensors may operate using passive infrared (PIR), ultrasonic, or dual-technology detection. The auditor should assess placement, sensitivity settings, time-delay configuration, and coverage area. Incorrect positioning or |



excessive delay times can reduce effectiveness and limit energy savings

Daylight sensors (photocells)	They adjust artificial lighting output based on available natural daylight. They are particularly effective in perimeter offices, glass-covered pack houses, and buildings with skylights. In properly configured systems, artificial lighting is dimmed or switched OFF when daylight levels are sufficient. The auditor should confirm calibration settings, sensor positioning, and integration with dimming or switching circuits. Poor calibration may result in flickering, under-lighting, or no effective energy reduction.
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Dimming systems	They are used to regulate light output according to task requirements, occupancy levels, or daylight availability. These may include manual dimmers, step-dimming drivers, 0–10V control systems, DALI (Digital Addressable Lighting Interface), or integrated smart lighting controls. Dimming reduces energy consumption proportionally to light output and enhances visual comfort. The auditor should establish whether installed luminaires are dimmable, whether drivers are compatible with control systems, and whether dimming is actively utilized or bypassed
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Figure 3 shows examples of lighting controls that can be used in a facility

Note: Distribution systems have been discussed under the chapter handling Power Systems.

3. Energy Audit of a lighting System

The energy audit of lighting systems has three fundamental steps as illustrated in figure 2.

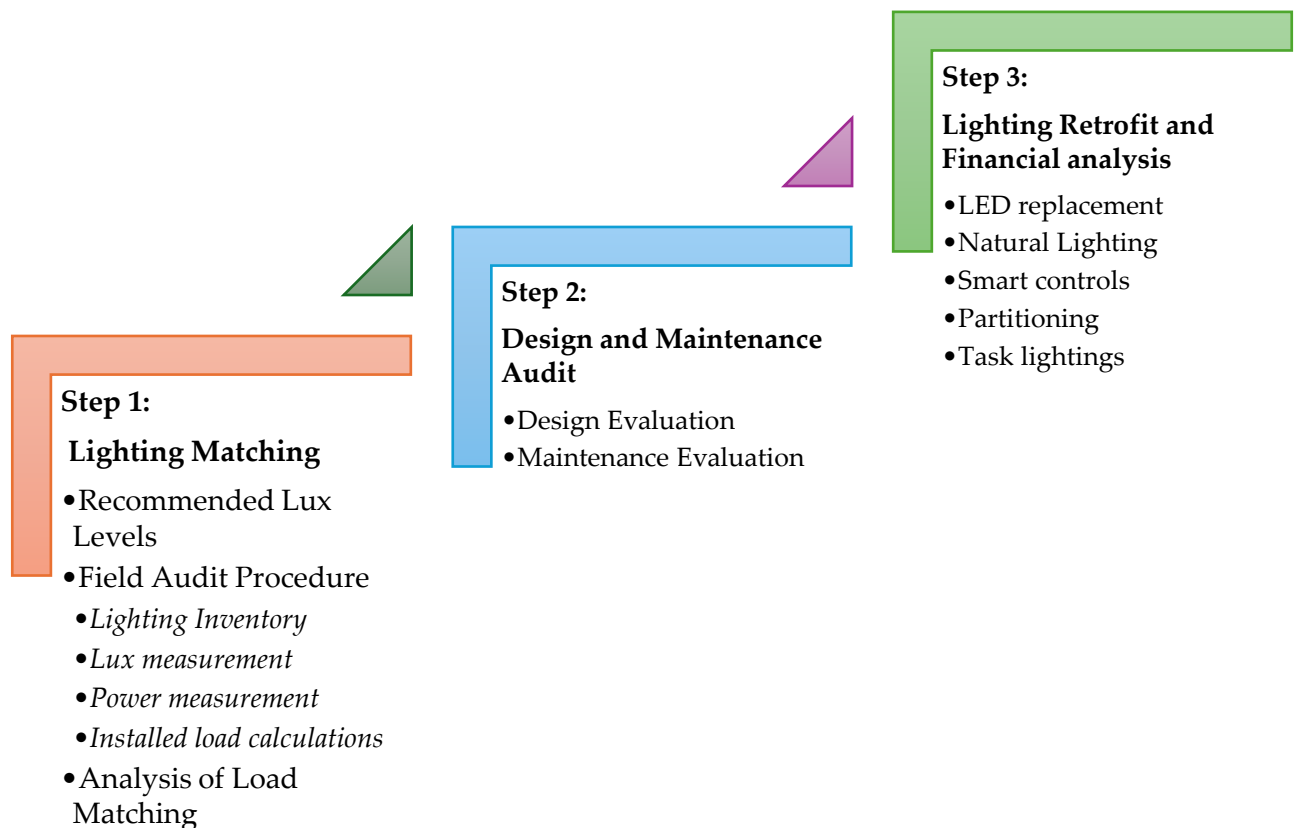


Figure 2 Steps in auditing power supply systems

Step 1: Supply–Demand Matching

The first stage in auditing a lighting system is the illuminance demand analysis. This helps to determine if the installed lighting system provides the appropriate level of illumination required for the tasks performed within the space. Efficient lighting is defined by how accurately the delivered illuminance matches the functional requirements of the area. The auditor should check if the area is over illuminated or

under illuminated. These cases represent inefficiencies as over illumination wastes energy, while the under illumination compromises productivity, safety, and quality.

Illuminance requirements vary depending on the nature of activities carried out in the space. Precision tasks such as flower grading, laboratory work, or inspection lines require higher lux levels than circulation areas, storage rooms, or corridors. The auditor should draw reference values from internationally recognized standards such as those developed by ISO, the International Commission on Illumination (CIE) and the Illuminating Engineering Society (IES) or the standards set for the specific operation by the facility.

As a general guide, table 1 shows the space area and the recommended lux.

Table 1: Space area and recommended lux requirement

Space	LUX requirement
Tea processing halls	300–500
Flower grading halls	500–750
Offices and Classrooms	300–500
Corridors and Storage areas	100–200

The auditor can use these values as benchmarks against which measured illuminance levels are compared during the audit. The auditor must always relate recommended lux levels to the specific visual tasks performed rather than applying generic targets.

Field Audit Procedure

The field assessment for supply demand matching consists of three integrated activities:

- i. conducting a lighting inventory
- ii. measuring illuminance levels, and

- iii. calculating installed lighting load parameters.

1. Lighting Inventory

The lighting inventory establishes the supply side of the system. The auditor should document the following parameters.

- i. Types of lights
- ii. lamp technology,
- iii. Rated wattage,
- iv. luminous flux (lumens per lamp),
- v. quantity installed,
- vi. mounting height,
- vii. spacing arrangement,
- viii. control method, and
- ix. operating hours per year.

Note: Where available, manufacturer datasheets could be used to confirm lumen output and driver performance characteristics.

This exercise enables the auditor to determine the total installed lighting load and to compute Lighting Power Density (LPD), expressed as watts per square meter (W/m^2). The LPD provides a quick indicator of relative efficiency and allows benchmarking against best practice values. Excessively high LPD values may indicate over-design, while abnormally low values may signal under-lighting or poor light distribution.

2. Illuminance Measurement

Illuminance measurement establishes the demand fulfillment level. Using a calibrated lux meter, the auditor should divide the area into uniform grid sections and take measurements at the working plane this is normally 0.8 meters above the floor for desks or benches, and floor level for circulation areas. Measurements should be recorded systematically to determine minimum, maximum, and average lux values.

The lux levels and the power density will assist the auditor to determine the installed the load efficacy (ILE), that is, the ratio of lux to power density.

The auditor should also evaluate the uniformity ratio, calculated as the minimum lux divided by the average lux. Poor uniformity may indicate improper spacing, unsuitable beam angles, or luminaire misalignment. Even if the average lux meets recommended values, poor uniformity can compromise visual comfort and task performance.

When natural light contributes significantly to illumination, measurements should be taken under representative operating conditions to avoid distortion of artificial lighting performance assessment.

3. Installed lighting Load Calculations

Installed load calculations quantify the electrical demand associated with the lighting system. The total lighting load is obtained by summing the wattage of all installed luminaires. This value is used to compute annual energy consumption based on operating hours:

$$\text{Annual Energy Consumption} = \text{Installed Load (kW)} \times \text{Operating Hours}$$

The auditor should also calculate Lighting Power Density (LPD):

$$LPD = \frac{\text{Total Installed Lighting Load}}{\text{Floor Area}}$$

This parameter enables comparison with recommended benchmarks for similar facilities

Analysis of Load Matching

After carrying out census of the lighting fixtures, the power and lux measurements, the auditor should compare them with the required illuminance levels for the space/facility/process under consideration.

If measured average lux exceeds recommended values by 20%, the system is over-illuminated, and energy savings can be achieved through fixture reduction, redistribution, dimming, lower wattage alternatives or redistribution in a case where lighting fixtures are concentrated in a particular section. Conversely, if measured values fall below recommended levels, the auditor must determine whether the deficiency arises from inadequate installed capacity, poor maintenance, inappropriate luminaire selection, age of lighting fixtures or excessive voltage drop.

The goal of supply–demand matching is not simply to reduce load but to optimize it ensuring that lighting quality, visual comfort, and operational requirements are met with the minimum necessary energy input. This step forms the technical foundation upon which design improvements, maintenance interventions, and retrofit recommendations are subsequently developed.

Step 2: Design and Maintenance Audit

Design

During design of lighting systems, the auditor should establish the following requirements:

- i. Optimum illuminance (lux levels)
- ii. Area of the room
- iii. Utilization factor of the room
- iv. Luminance of the lamps
- v. Maintenance factor of the lamp

Optimal lux levels for a particular space/facility/process can be obtained from the Standards. Coefficient of Utilization (CU) accounts for room geometry, luminaire

efficiency, colour of the room and can be calculated based on parameters provided. A guide can however be used to read off the CU table in **Appendix 1**. The Maintenance Factor (MF) accounts for lumen depreciation due to aging and dirt accumulation and it is provided by the manufacturer of the lighting fixtures.

The fundamental relationship governing lighting performance is:

$$Lux = \frac{Lumens \times Coefficient\ of\ Utilization \times Maintenance\ Factor}{Area}$$

Once the auditor has established the required lux, they can design the lighting fixtures required to meet this requirement.

Maintenance

Maintenance of lighting fixtures is an important factor in sustaining the efficiency and longevity of the fixtures. Proper maintenance of the lighting fixtures includes regular cleaning to prevent dust accumulation and replacement of faulty components. For example, cracked reflectors or one faulty lamp in a fixture should be replaced. The faulty lamp could be a result of a faulty ballast or starter. In a scenario whereby the auditor establishes that the measured lux levels is lower than the expected level, they should establish whether this could be due to poor maintenance of the fixtures.

Appendix 1

Coefficients Of Utilization - Zonal Cavity Method

		Effective Floor Cavity Reflectance: 20%																	
RCC %:		80				70				50			30			10			0
RW %:		<u>70</u>	<u>50</u>	<u>30</u>	<u>0</u>	<u>70</u>	<u>50</u>	<u>30</u>	<u>0</u>	<u>50</u>	<u>30</u>	<u>20</u>	<u>50</u>	<u>30</u>	<u>20</u>	<u>50</u>	<u>30</u>	<u>20</u>	<u>0</u>
RCR: 0		1.07	1.07	1.07	1.07	.99	.99	.99	.50	.83	.83	.83	.69	.69	.69	.56	.56	.56	.50
1		.98	.94	.90	.87	.90	.87	.83	.43	.73	.71	.69	.61	.60	.58	.50	.49	.48	.43
2		.89	.82	.76	.71	.82	.76	.71	.37	.65	.61	.57	.54	.51	.49	.44	.42	.41	.36
3		.82	.72	.65	.59	.75	.67	.61	.32	.57	.52	.48	.48	.44	.42	.39	.37	.35	.31
4		.75	.64	.56	.50	.69	.60	.53	.27	.51	.46	.41	.43	.39	.36	.35	.32	.30	.26
5		.69	.57	.49	.43	.63	.53	.46	.24	.46	.40	.36	.38	.34	.31	.32	.29	.26	.23
6		.63	.51	.43	.38	.58	.48	.41	.21	.41	.35	.31	.35	.31	.27	.29	.26	.23	.20
7		.59	.46	.38	.33	.54	.43	.36	.19	.37	.32	.28	.32	.27	.24	.26	.23	.21	.18
8		.54	.42	.34	.29	.50	.39	.32	.17	.34	.28	.25	.29	.25	.22	.24	.21	.19	.16
9		.51	.38	.31	.26	.47	.36	.29	.15	.31	.26	.22	.27	.22	.19	.22	.19	.17	.15
10		.47	.35	.28	.23	.44	.33	.27	.14	.29	.23	.20	.25	.20	.18	.21	.18	.15	.13

$$RCR = \frac{2.5 \times RCH \times P}{A}$$

A = area = L x W

P = perimeter 2(L+W)

RCR = (Room Cavity Height): The distance from the light fixture to the work plane

RCC% (Reflectance of Ceiling Cavity): The percentage of light reflected by the ceiling. A higher percentage (e.g., 80% for white) means better light utilization

RW% (Reflectance of Walls): The percentage of light reflected by the walls. It affects how much light is redirected to the work plane.

RCC% and RW%: These are not calculated via a formula, but are chosen based on the actual material and colour of the ceiling/walls (e.g., white paint = 70-80%, light wood = 30-50%, dark materials = 10-20%)

EXAMPLE 1

Measurements

Open Office room size = 100 m²

Number of Lighting fixtures = 20

Rating per fixture = 35W (including ballast).

Total working hours of the fixture since installation = 8,000 hours

Expected life span = 10,000 hours

Measured lux = 850 lux

Recommended lux = 500 lux

Total energy measurements for 8 hours is 6.676 kWh.

Working hours = 8 hours per day, 5 days per week

Table xxx: Measured average hourly power demand for lighting

Time (hour)	Power demand (kW)
8.0	0.840
9.0	0.826
10.0	0.833
11.0	0.812
12.0	0.847
13.0	0.854
14.0	0.833
15.0	0.831

Analysis

Observations

- Measured lux = 850 lux. The lighting system is oversized by
 $850 - 500 = 350$ lux or $350/500 = 0.7$ (70%)
- Annual working hours = $8 \times 5 \times 52 = 2,080$ hours
- Total Power demand for 20 fixtures = $20 \times 35W = 700$ W = 0.7kW
- Measured average power demand for 8 hours = $6.664/8 = 0.833$ kW
- Annual energy consumption if the current situation remains, assuming the lights run at design condition
 $= 0.7 \times (8 \times 5 \times 52) = 0.7 \times 2,080 = 1,456$ kWh
- Annual energy consumption if the current situation remains, assuming the lights run at current state without any farther deterioration
 $= 0.833 \times (8 \times 5 \times 52) = 0.833 \times 2080 = 1,732.64$ kWh
- Installed Load Efficacy (ILE)**
 That is a measure how well the lighting system produces light per power input.
 Power density (P_{den})



$$P_{den}(W/m^2) = \frac{\text{Total actual power}(W)}{\text{Area}(m^2)}$$

Current ILE

$$P_{den}(W/m^2) = \frac{1,732.64}{100} = 17.33 W/m^2$$

$$ILE = \frac{LUX}{P_{den}(W/m^2)} = \frac{850}{17.33(W/m^2)} = 49.08 lux/W/m^2$$

Design ILE

$$P_{den}(W/m^2) = \frac{1456}{100} = 14.56 W/m^2$$

$$ILE = \frac{LUX}{P_{den}(W/m^2)} = \frac{850}{14.56(W/m^2)} = 58.38 lux/W/m^2$$

- Required ILE is 10.19 Lux/W/m² at Lux of 500

Therefore, required power density (RP_{den}) is such that

$$ILE = \frac{LUX}{RP_{den}(W/m^2)} = \frac{500}{RP_{den}(W/m^2)} = 58.38 lux/W/m^2$$

$$RP_{den}(W/m^2) = \frac{500}{58.38} = 8.56(W/m^2)$$

Actual power required

$$\text{Actual power}(W) = RP_{den}(W/m^2) \times \text{Area}$$

$$\text{Actual power}(W) = 8.56(W/m^2) \times 100 = 856W$$

Lights fixture of T8 required are

$$LF = \frac{500}{850} \times 20 = 11.8 \text{ Fixtures}$$

Scenario 1

Assume we change all the 20 fixtures at this stage. What do we expect after 2000 hours

- Assuming current state remains without changing, energy consumption will be
= 0.833 x 2,000 = 1,666 kWh

- Assuming all 20 fixtures are changed, the energy consumption will be
 $= 0.7 \times 2,000 = 1,400.0 \text{ kWh}$

Energy savings in 2000 hours will be $1,666 - 1,400 = 266 \text{ kWh}$

Financial savings $= 266 \times 21 = \text{KSh } 5,586$

Net financial savings

Cost of one fixture is KSh 500

Cost of 20 fixtures $= 20 \times 500 = \text{KSh } 10,000$

Net financial savings $= 5,586 - 10,000 = -\text{KSh } 4,414$

We can conclude that it is not worth replacing all these lamps with the same type of lamp for the remainder of its lifespan.

Scenario 2

Assume delamping to achieve 500 lux, that is retaining 11.9 fixtures (about 12) fixtures. Under current situation energy for 2,000 hours.

$0.833 \times (12/20) \times 2,000 = 999.6 \text{ kWh}$

Energy savings

$1,666 - 999.6 = 666.4 \text{ kWh}$

Financial savings

$666.4 \times 21 = \text{KSh. } 13,994.4$

Scenario 3

Assume lights are reduced to 12 to achieve 500 lux using new lamps. Under the current situation energy for 2,000 hours.

$(12 \times 35/1000) \times 2,000 = 840 \text{ kWh}$

Energy savings

$1,666 - 840 = 826 \text{ kWh}$

Financial savings

$(826 \times 21) - (500 \times 12) = \text{KSh. } 11,346$

Scenario 4

Assume LED retrofit was done. T8 32W tube can be replaced with LED of 18 Watts.

Energy savings

$999.6 - (12 \times 0.018 \times 2,000) = 567.6 \text{ kWh}$

Financial savings

$567.6 \times 21 = \text{KSh } 11,919.6$

Assume cost of LED fixture is KSh 3,500

Cost of 12 fixtures is $12 \times 3,500 = \text{KSh } 42,000$

Savings in 2000 hours

$$11,919.6 - 42,000 = -\text{KSh } 30,080$$

Considering that LED lifespan is 25,000 hours, we can compute the energy savings from replacing the 12 fluorescent lamps with LEDs.

The energy consumption by fluorescent over the 25,000 hours is,

$$= 0.833 \times (12/20) \times 25,000 = 12,495 \text{ kWh}$$

The energy consumption by LEDs over 25,000 hours is,

$$= 0.018 \times 12 \times 25,000 = 5,400 \text{ kWh}$$

The cost incurred when using fluorescent will be the cost of energy over the period and the investment cost for installing the lights

The cost of energy will be,

$$= 12,495 \text{ kWh} \times 21 = \text{KSh. } 262,395$$

The investment cost is,

$$= 2 \times 500 \times 12 = \text{KSh. } 12,000$$

The total costs incurred will be:

$$= \text{Investment cost} + \text{Energy Cost}$$

$$= \text{KSh. } 12,000 + \text{KSh. } 262,395$$

$$= \text{KSh. } 274,395$$

The total cost incurred for LEDs on the other hand will be the cost of energy and investment cost

$$= (5,400 \text{ kWh} \times 21) + (\text{KSh. } 3500 \times 12)$$

$$= \text{KSh. } 155,400$$

Comparing the two investments, the net savings from LEDs installation will be KSh 118,995.

From these, we can conclude that the facility can consider installation of LEDs before the end of life of fluorescent lamps.

EXAMPLE 2:

Lights Example

A facility has:

- an area of 200 m²
- 40 fixtures, 4ft, T12, with double lamps each 40 W and ballast of 7 watts
- Design Lux requirement is 520 lux
- Measured lux is 465 lux
- Measured average power 4.350 kW
- Lunch hour between 13hr and 14 hr offices are empty

Power demand table

Hour	Power Demand
7	4.3935
8	4.4805
9	4.1325
10	4.176
11	4.263
12	4.437
13	4.3935
14	4.176
15	4.611
16	4.437
17	4.35
Ave	4.35

State energy saving measures

- Motion sensors – lunch hour
- Clean fixtures to improve
- Retrofit to a more efficient technology

How does power density and Installed Load Efficacy (ILE) improve

Assume 2000 annual light working hours, how much energy savings per year does:

- Motion sensors save
- Retrofit to LED save and how does power density and ILE improve?

Solution

Design power demand

$$P_{des} = Fix \times W/fix$$

$$P_{des} = 40 \times 87 = 3,480 W$$

Motion sensors will minimize the lunch our power

Number of hours per year eliminated = 5 hours/week x 52 weeks

Minimum Energy savings = $260 \times 3.48 = 904.8 \text{ kWh}$

Retrofit to LED,

LED light has power rating of 16 watts. With a double fixture, the power rating is 32 Watts.

$$P_{LED} = 40 \times 32 = 1.280kW$$

Energy savings

Assuming no motion sensors

$$Eng_{sav} = (4.35 - 1.28) \times 2000 = 6,140kWh$$

With motion sensors

$$Eng_{savsens} = (4.35 \times 2000) - (1.28 \times 1740) = 6,472.8kWh$$

Calculate power density during measurements

$$P_{den}(W/m^2) = \frac{\text{Total actual power}(W)}{\text{Area}(m^2)}$$

$$P_{den}(W/m^2) = \frac{4,350(W)}{200(m^2)} = 21.75(W/m^2)$$

Installed Load Efficacy (ILE) as per current condition

$$ILE = \frac{LUX}{P_{den}(W/m^2)} = \frac{465}{12.75(W/m^2)} = 36.47lux/W/m^2$$

Power density after LED retrofit

$$P_{denled}(W/m^2) = \frac{1,280(W)}{200(m^2)} = 6.4(W/m^2)$$

$$ILE_{led} = \frac{LUX}{P_{denled}(W/m^2)} = \frac{520}{6.4(W/m^2)} = 81.25lux/W/m^2$$

With the LED retrofits the power density decreases and the ILE increases. These figures are good for benchmarking purposes.

EXAMPLE 3

A room has the following characteristics

- Floor dimensions 20m x 35 m= 700 m²
- Due to unpainted ceiling the Reflectance of Ceiling Cavity (RCC%) was found to be 50%
- Due to unpainted ceiling the walls Reflectance of Walls (RW%) was found to be 30%
- The distance from the light fixture to the work plane is 1.75 metre

By what percentage will the lux level improve if:

- Ceiling was painted to achieve Reflectance of Ceiling Cavity (RCC%) of 70%
- Walls are painted to achieve Reflectance of Walls (RW) of 70%
- Distance of light lowered to 1.2 metres

To calculate the coefficient of utilization (CU), first you should calculate the Room Coefficient of Reflectance (RCR)

$$RCR = \frac{2.5 \times h \times 2(L + W)}{L \times W}$$

$$RCR = \frac{5 \times 1.75 \times (35 + 20)}{35 \times 20} = 0.6875$$

From the table in Appendix 1 were

RCR = 0.6875 = (0.69)

RW = 30%

RCC = 50%

CU = 0.7475 (interpolation)

Lux level assuming maintenance factor of 0.85

$$Lux = \frac{Lumens \times Utilization Factor \times Maintenance Factor}{Area}$$

$$Lux = \frac{Lumens \times 0.7475 \times 0.85}{700}$$

Improved state (Painted Ceiling, Walls and lowering of distance)

$$RCR = \frac{5 \times 1.2 \times (35 + 20)}{35 \times 20} = 0.47$$

From the Appendix 1

RCR = 0.47

RW = 70%

RCC = 70%

CU = 0.99 - 0.90 (interpolation = 0.945)

$$Lux = \frac{Lumens \times 0.945 \times 0.85}{700}$$

Assume LED Light 16-watt 4ft LED tube where lumens is 2000

Dirty room

$$Lux = 0.0009077 \text{ Lumens}$$

Clean room

$$Lux = 0.0011475 \text{ Lumens}$$

Assume you want to achieve lux level of 500

How many lights will you need in each situation?

Dirty room

$$Lux = 0.0009077 \text{ Lumens}$$

$$\begin{aligned} \text{Number of lights} &= \frac{500}{0.0009077 \times 2000} \\ &= 275.42 \end{aligned}$$

Clean room

$$Lux = 0.0011475 \text{ Lumens}$$

$$\begin{aligned} \text{Number of lights} &= \frac{500}{0.0011475 \times 2000} \\ &= 217.86 \end{aligned}$$

The difference is approximately 57 lamps.

Implementation of these measures will save energy consumption of 57 lamps.