MFVI Energy Efficiency Audit Training

Module 1.1: Introduction to Efficient Lighting

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Introduction to MFVI

MiPyMEs Futuros Verdes Initiative (MFVI) advances clean, reliable, and affordable energy solutions for micro-, small-, and medium-sized businesses (Spanish acronym “MiPyMEs”) in the Yucatan Peninsula through targeted technical training and affordable financial support. MFVI aims to increase financial inclusion, maximize the energy cost savings available to MiPyMEs, empower business owners to make strategic energy investments, and catalyze economic growth within the MiPyMEs sector.

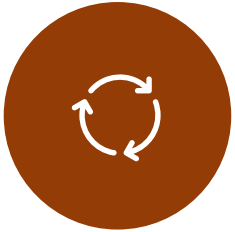
The following modules were developed as part of a two-part targeted training series to equip university students with the skills and expertise needed to conduct Level-2 energy audits for local MiPyMEs. This module was designed for undergraduate students from different backgrounds to perform audits in for small and micro business buildings. The energy savings measures will reflect this overall purpose.

What Is the Purpose of MFVI?

Help MiPyMEs implement energy efficiency

Determine simple energy conservation measure (ECM) savings through targeted energy efficiency audits

Enable MiPyMEs to qualify for affordable “green” loans



Begin a cyclical process of building green credit

MFVI Two-Part Training Process

Phase 1 Training

- Understand and measure energy efficiency via on-site audits

Phase 2 Training

- Conduct analysis of data collected during audits, and recommend ECMs

Training Breakdown

Module 1: Lighting

1.2 Lighting Analysi1.1 Introduction to Efficient Lighting

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Module 2: Plug Loads

2.1 Introduction to Plug Loads

2.2 Plug Load Analysis

Module 3: HVAC

3.1 Introduction to Cooling Systems

3.2 HVAC Analysis

Introduction to Efficient Lighting

Training Module 1.1

Module Map

1. Determine an appropriate light level for a given space:
    - Record operational hours
    - Measure the daytime and nighttime illuminance in a space
        - Create illuminance maps.
2. Determine energy-efficient ways to deliver lighting:
    - Count the number of fixtures and gather details about the fixture type and wattages
    - Calculate lighting power density (LPD) of the space and compare against standards to see if lighting is efficient
    - Account for sensors and other lighting controls.

Key Terms and Definitions

Illuminance: The metric used to measure light intensity within the space. It is the amount of light falling on a surface. The luminous flux of the light source is measured in lumens.

Lux (lx): Lumens per meter foot (Lumens/m^2)

Footcandles (fc): Lumens per square foot (Lumens/sf)

Conversions: 1 lx = 0.0929 fc

1 fc = 10.76391 lx

Applied Student Exercise

1. Convert 50 fc to lx
2. Convert 100 lx to fc
3. In a common 6 m x 6 m office space, there is a lamp with 550 lx-rated luminous intensity. What is the luminous flux in the room?

What You Will Need

- A copy of your field tool sheet
- A luxmeter
- Pencil, ruler and extra sheets of paper
- Tape measure (if available).

Determine an Appropriate Light Level for a Given Space

Step 1: Record Operational Hours

- Calculate and record operational hours per workday. This can typically be found by talking to employees.
- Calculate and record operational hours (if any) on average per weekend day, and any evening hours of operation (nighttime* schedules).

Note that nighttime refers to the last 3 hours of occupation of the building during the work period.

Lighting Audit Procedure I: Determining Appropriate Light Levels in a Space

1. Record operational hours:
    - Calculate and record operational hours per workday. This would typically be found through talking to the employees.
    - Calculate and record operational hours (if any) on average per weekend day, and any evening hours of operation (nighttime* schedules).

**Nighttime refers to the last 3 hours of occupation of the building during the work period.*

Getting to Know a Lux-Meter

Refer to this video for a tutorial on how to use a lux meter.

Image by amazon.com

Notes on Taking Measures…

- When measuring the light in an office, take readings at “desk level” (0.75m/30” above the finished floor).
- Hallway measurements should be taken at floor level
- Restroom measurements should be taken at counter height.

Step 2: Measure Ambient (Baseline) Light

Ambient or baseline light will be referred to as *L1*.

To measure ambient light:

- Turn off the lights you want to measure.
- From a central location in the space, take a measurement with your light meter. This will be your “baseline” measurement.

Step 3: Record Current Lighting Measurements

Current lighting measurements will be referred to as *L2*.
To measure current lighting:

- Turn on the lights you want to measure
- Allow a few minutes for the lights to reach full intensity
- From the same central location in the space, take the reading on your light meter.

Step 4: Calculate Illuminance

The illuminance of the lights is the difference between the baseline measurement and the current lighting system's measurement.

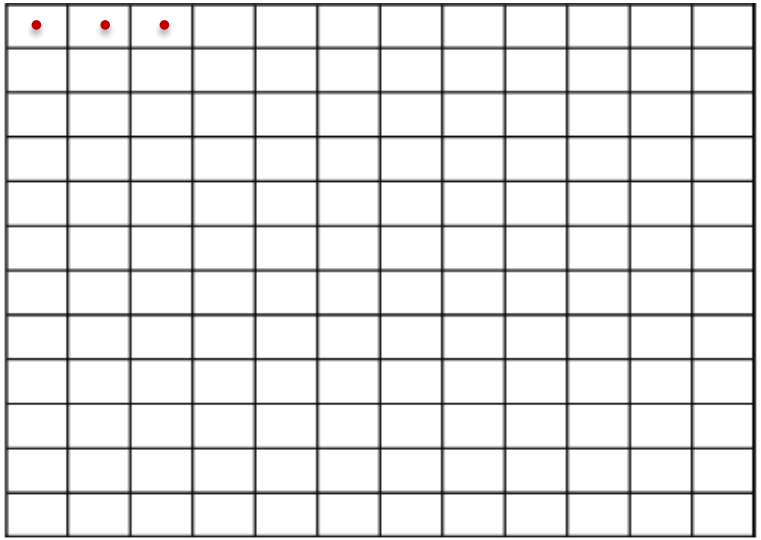
$$Illuminance\ (\Delta L) = L2 - L1$$

Applied Student Exercise

- Step 1: Stand in the center of the room you are in
- Step 2: Get an illuminance reading
- Step 3: Share your reading in the chat.

Step 5: Create an Illuminance Map

- Draw an outline of the room
- Divide the room into grids:
  - For rooms ≤13 m^2 in area, grid lines should be 0.50m apart
  - For rooms >13 m^2 use grid lines 3 m apart
- Record light levels in the center of each box created by the grid (e.g., red dots to the right).



Step 6: Repeat These Procedures at “Nighttime”

- Take nighttime measurements in the same places as you did during the day to determine daylight contribution
- Note sky conditions (clear, partly cloudy, cloudy, etc.)
- Note the readings down in a separate illuminance map.

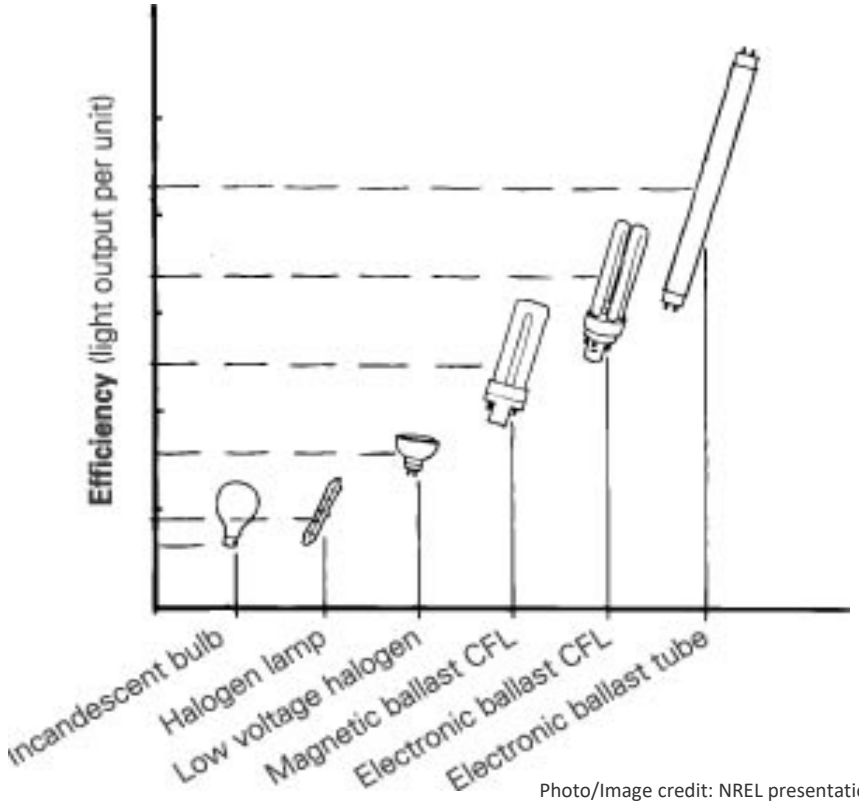
Determine Energy-Efficient Ways to Deliver Lighting

Step 7: Count Fixtures

- Count the lamps and/or ballasts in each room.
- Note these data points for each fixture in your field guide:
  - Type
  - Manufacturer
  - Wattage
  - Lamp color
  - Lumen levels
  - Number of lamps
  - Color temperature
  - Ballast factor (if applicable, only for fluorescent fixtures).

If some of this data is not printed on the equipment, but at least the manufacturer and model are. This information can be found via an online search.

Step 7: Count Fixtures



Photo/Image credit: NREL presentation to DOE: Energy Assessment Training, Lighting

Step 7: Calculate Space Area

- Measure the length and width of the space with a tape measure. If this isn't possible, use estimations.
- Estimate the ceiling height. Particularly, determine if it is ≤ 5 meters.

Step 8: Calculate LPD

From the data you have collected:

- Calculate space area (A = length x width)
- Calculate total wattage in space (W)
- For ballasts; fixture wattage = lamp wattage x number of lamps x ballast factor (B.F.)
- Calculate space LPD (W/A).

Compare the LPD with LPD levels in the Field Tool (page 3).

Applied Student Exercise

You are conducting an audit of a closed office room. You measure the total wattage to be 150W. The room is 5 m x 5 m.

1. What is the LPD of the room?
2. Do you think this is acceptable?

Exercise #3

You are conducting an audit of a closed office room. You measure the total wattage to be 150W. The room is 5m x 5m.

1. What is the LPD of the room?
2. Do you think this is acceptable?

Step 9: Collect Data on Sensors and Light Control

Look for:

- Existing occupancy sensors
- Dimming ballasts
- Lighting control systems
- Daylight sensors (if applicable).

If these exist, note details such as type, manufacturer, and model number.

Step 10: Look for Opportunities to Reduce LPD

- Determine whether space is too bright; if yes, LPD can be reduced by strategically reducing number of lamps in the space
- Look at LPD recommendations from page 3 in the Field Guide. Ask yourself: What is the best way to achieve the recommended lighting levels?
- Replacing existing lights with LEDs
- Install sensors (occupancy/dimming)
- Calculate how much LPD reduction can be achieved (you will learn how to do this in Phase 2 training).

Questions?

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