MFVI Energy Efficiency Audit Training

Module 2.2: Plug Loads Analysis

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May 2022
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 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

Enable MiPyMEs to qualify for affordable “green” loans

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

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

1.1 Introduction to Efficient Lighting
1.2 Lighting Analysis

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
Plug Load Analysis

Training Module 2.2
What You’ll Need for the Analysis

• A copy of your field tool sheet with all information collected during audits
• A copy of the ENERGY STAR® payback calculator provided
• A copy of the equipment payback calculator provided.
Before We Start: Review the Equipment Data You Have Collected

- What are the plug loads with the highest wattages?
- Which plug load numbers are the highest?
- Which plug loads are used the most in a day?

Start calculating payback for the plug loads that you think consume the most energy. This is good practice in the industry if you have limited time.
Recommend Simple ECMs With Payback Periods
Step 1: Power and Sleep Settings

Set:
- “Turn off screen” to 5 minutes
- “Sleep” to 10 mins
- “Turn off hard disk” to 10 mins.
Step 2: Battery Settings

Activate “power saver mode.”
Step 3: Screen Saver Settings

Turn off screen saver settings. Use the search button to navigate to the screen saver settings page.
Step 3: Calculate Energy Saved Using the ENERGY STAR Payback Calculator

Use the circled link to access the ENERGY STAR page.

- Click the “Calculate your potential savings” tab, as shown.
- This will download the “LowITcarbonsavings” calculator sheet.
- The sheet has four main tabs: “Start here,” “Adjust-power draw,” “Adjust-sleep settings,” and “Adjust-usage patterns.”
- The “Results” tab reflects results for the changes made in the four tabs.
Navigating the Payback Calculator: “Start here” tab

- Input the number of desktop computers, monitors, notebooks and displays in the required fields.
- For electricity rate, enter the rate directly into the yellow box provided. The dropdown has information only for U.S. states.
- For turn-off rate, assume 70% as default.

Image by energystar.gov
Navigating the Payback Calculator: Adjust Sleep Settings

- Change the options circled to 10 minutes each.
- The time taken before the systems go to sleep/standby is determined from Module 2.1.
Navigating the Payback Calculator: Adjust Power Draw

It is not recommended to change the values in this tab, unless there is specific information required to change this.
Navigating the Payback Calculator: Adjust Usage Patterns

- This tab would be populated by information obtained on work schedules from Lighting Audit 1.1.
- Leave the discount rate at 4.0%.

**ENERGY STAR Computer Power Management Savings Calculator**

*How are your PCs used?*

**Instructions:** Enter information about your organization.

1. How many **hours** in a typical workday in your organization?
2. How many **days** in a typical work week in your organization?
3. How many **non-working days per year** are typical for your organization? E.g., vacation days, sick days, holidays, etc.?
4. What **(real) discount rate** do you want to use in calculating 3-years savings?

After completing this page, click the green "Results" tab below to view your estimated savings OR use the other red "Adjust" tabs below to perform customized calculations specific to your environment.

Photo by energystar.gov
Navigating the Payback Calculator: Results

- The Results tab gives you an annual energy savings and cost savings over the year.
- It also offers dollar savings over 3 years, keeping in mind the discounted rate.
- It is also useful to look at the CO2 emissions prevented, although it is out of the scope of today’s module.

<table>
<thead>
<tr>
<th>Savings Estimate</th>
<th>3-Year Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tons of CO2 Emissions Prevented</td>
</tr>
<tr>
<td><strong>Energy (kWh)</strong></td>
<td><strong>Dollars ($)</strong></td>
</tr>
<tr>
<td>Savings from desktop monitors going into sleep mode:</td>
<td>2,607.8</td>
</tr>
<tr>
<td>Savings from notebook displays going into sleep mode:</td>
<td>359.5</td>
</tr>
<tr>
<td>Total savings from monitor/display sleep modes:</td>
<td>2,967.3</td>
</tr>
<tr>
<td>Savings from desktop computers going into sleep mode:</td>
<td>3,629.1</td>
</tr>
<tr>
<td>Savings from notebook computers going into sleep mode:</td>
<td>359.5</td>
</tr>
<tr>
<td>Total savings from computer sleep modes:</td>
<td>3,988.6</td>
</tr>
<tr>
<td><strong>Total savings:</strong></td>
<td><strong>6,855.9</strong></td>
</tr>
</tbody>
</table>

Photo by energystar.gov
Navigating the Payback Calculator: Notes

- The ENERGY STAR savings calculator is based on a comprehensive study done on power draws of a computer on different modes.
- This can be used to report out final payback periods to customers.
- Click any of the tabs and “Unhide” worksheets to look at calculations, if needed.

Photo by energystar.gov
Let’s calculate the payback for all the computers in one building! 😊
Recommend Simple ECMs With Payback Periods

Replace existing equipment with ENERGY STAR equipment
Step 1: Calculate Annual Energy Use and Annual Energy Cost of the Plug Loads in a Space

For each space in the building, input the following values into the payback calculator provided:

- Space name
- Plug load name and type
- Number of plug loads of the particular type
- Wattage
- Weekday and weekend hours of operation.

The payback calculator will then calculate the annual energy use and energy cost of the lights in that particular space. Refer to the payback calculator for more information on how to calculate energy use and costs.
• If you don’t have the wattage of a plug load, try googling the model # to get a wattage of the product.
• If you used a modern watt meter to measure a load’s energy use in kWh, directly enter the annual energy use of the load in the appropriate tab in the payback calculator.
Step 2: Look up Alternate Products for Plug Loads

• For each load, use the [ENERGY STAR](https://www.energystar.gov) website to look for certified low-efficiency products.
• Navigate through filters to find the most similar product to the one being replaced.
Step 2: Look up Alternate Products for Plug Loads

Energy Efficient Products for Consumers

Find all the information you need to choose ENERGY STAR certified products including rebates and retailers near you. Products that earn the ENERGY STAR label meet strict energy-efficiency specifications set by the U.S. EPA helping you save energy and money while protecting our climate.

Appliances
- Air Purifiers (Cleaners)
- Dehumidifiers
- Residential Clothes Dryers
- Residential Clothes Washers
- Residential Laundry Center
- Residential Combination All-in-One Washer-Dryer
- Residential Dishwashers
- Residential Freezers
- Residential Laundry Sets
- Residential Refrigerators

Data Center Equipment
- Data Center Storage
- Enterprise Servers
- Large Network Equipment
- Small Network Equipment
- Uninterruptible Power Supplies

Office Equipment
- Computers
- Displays
- Imaging Equipment

Other
- Electric Vehicle Chargers
- Lab Grade Refrigerators and Freezers
- Pool Pumps
- Vending Machines
- Water Coolers

Electronics
- Audio/Video
- Set-Top Boxes
- Telephones
- Televisions

Building Products
- Storm Windows
- Windows, Doors, & Skylights
- NFRC Directory

Heating & Cooling
- Boilers
- Central Air Conditioners

Water Heaters
- Commercial Water Heaters
- Water Heaters

Photo by energystar.gov
Step 2: Look up Alternate Products for Plug Loads

Photo by energystar.gov
Step 3: Calculate Annual Energy Savings, Cost Savings, and Simple Payback

- Note the product’s annual energy use in the plug loads payback calculator to calculate annual energy and cost savings.
- The calculator will also calculate a simple payback period.
Let’s Do the Math!

Annual Hours of Usage
1. \[\text{Annual Hours of Usage} = (\text{weekday hours of use} \times 260 \text{ weekdays per year}) + (\text{weekend hours of use} \times 100 \text{ weekends per year})\]

Annual Energy Use (kWh)
2. \[\text{Annual Energy Use (kWh)} = \frac{\text{Annual Hours of Usage} \times \text{lamp wattage (W)} \times \text{number of loads}}{1000}\]

Annual Energy Cost (USD)
3. \[\text{Annual Energy Cost (USD)} = \text{Annual Energy Use (kWh)} \times \text{electricity tariff rate} \left(\frac{\$}{kWh}\right)\]
Let’s Do More Math!

1. **Annual Energy Cost Savings** (kWh)
   
   \[ \text{Annual Energy Cost Savings} = \text{energy cost of existing lamp} - \text{energy cost of replacement lamp} \]

2. **Labor Cost**
   
   \[ \text{Labor Cost} = \text{labor rate per hour} \times \text{Number of hours} \]

3. **Total Cost Savings** ($)
   
   \[ \text{Total Cost Savings} = \text{Annual Energy Cost Savings} - \text{total labor costs} - \text{procurement costs of lamps} \]

4. **Simple payback ratio**
   
   \[ \text{Simple payback ratio} = \frac{\text{Total Cost}}{\text{Total Cost Savings}} \]

A payback of 0-2 years is generally considered good for lighting ECMs.

Note: Procurement cost of lamps might vary from location to location.
Using the Payback Calculator

The payback calculator can be used to calculate key financial metrics such as annual energy cost savings (in $) and simple payback periods for implementing a specific ECM.

### Summary Metrics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total energy savings (kWh)</td>
<td>3870</td>
</tr>
<tr>
<td>Energy cost savings ($/yr)</td>
<td>658</td>
</tr>
<tr>
<td>Total number of loads</td>
<td>5</td>
</tr>
<tr>
<td>Total lamp procurement costs ($)</td>
<td>25</td>
</tr>
<tr>
<td>Total labor costs ($)</td>
<td>0</td>
</tr>
<tr>
<td>Total cost savings ($)</td>
<td>633</td>
</tr>
<tr>
<td>Simple payback</td>
<td>0.04</td>
</tr>
</tbody>
</table>

### Plug Loads ECM Analysis

This is a simple payback calculator. It takes into account the total energy cost savings over a year due to changing plug load devices, and calculates a simple payback. Row 13 provides an example.

### Space Load Details

<table>
<thead>
<tr>
<th>Space name</th>
<th>Load name</th>
<th>Load type (vending machine, refrigerator, etc.)</th>
<th>Number of loads</th>
<th>Watts</th>
<th>Weekday hours per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load type 1</td>
<td>VM-1234</td>
<td>Vending machine</td>
<td>1</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>Load type 2</td>
<td>VM-3456</td>
<td>Vending machine</td>
<td>2</td>
<td>50</td>
<td>10</td>
</tr>
</tbody>
</table>
Let’s use the payback calculator to calculate annual energy use and costs of the loads in one of your spaces in the building! 😊
Pause and Recap

Questions?
Recommend Simple ECMs With Payback Periods

Removing unwanted equipment
Removing Extraneous Loads in the Space

• Look at A3 for all the extraneous plug loads you have documented in the building
• If the plug loads will not be noticeable when removed, remove the equipment.
• Remember that employees are priority! If they do not recommend removing equipment, DO NOT do it!
Calculating Energy and Cost Savings for Removing Loads

• To calculate energy and cost savings for removing a load, simply enter the replacement load and procurement costs as 0 in the respective columns in the spreadsheet.
  – Note that labor costs will remain non-zero.

<table>
<thead>
<tr>
<th>Replacement Load Metrics</th>
<th>Energy Efficiency Metrics</th>
<th>Total Savings</th>
<th>Total Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacement load wattage</td>
<td>Watt-hours per year for replacement</td>
<td>Annual energy use after replacement (kWh)</td>
<td>Annual energy cost ($/yr)</td>
</tr>
<tr>
<td>20 $5.00</td>
<td>52,000</td>
<td>52</td>
<td>$8.84</td>
</tr>
<tr>
<td>20 $5.00</td>
<td>104,000</td>
<td>104</td>
<td>$17.68</td>
</tr>
<tr>
<td>0 $ -</td>
<td>-</td>
<td>-</td>
<td>$ -</td>
</tr>
<tr>
<td>0 $ -</td>
<td>-</td>
<td>-</td>
<td>$ -</td>
</tr>
</tbody>
</table>
Pause and Recap

Questions?
Recommend Simple ECMs With Payback Periods

Other measures
Other Measures To Consider: Replace Desktop Computers With Laptops

- Laptops consume 50%-80% less electricity than desktop computers, as they operate on a battery.
- Laptops cost between $1,000 to $2,000, so calculate payback accordingly.

<table>
<thead>
<tr>
<th>Computer Type</th>
<th>Processor Type</th>
<th>Active/On (Watts)</th>
<th>Suspended (Watts)</th>
<th>Off (Watts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Docked Laptop w/ LCD</td>
<td>Intel Core</td>
<td>62</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Desktop w/ LCD</td>
<td>Intel Core</td>
<td>115</td>
<td>6</td>
<td>3.5</td>
</tr>
<tr>
<td>Desktop w/CRT</td>
<td>Intel Core</td>
<td>145.25</td>
<td>16</td>
<td>7</td>
</tr>
</tbody>
</table>
Other Measures To Consider: Vending Misers

- Misers are devices that are attached to a vending machine.
- They help turn off the machine when not in use, monitor the room temperature, and regulate cooling energy required by the system.
- They save an average of 45% electricity per year.
- They cost $165 per unit.

Photo by tufts.edu
Other Measures To Consider: Advanced Power Strips

- Advanced power strips help monitor the energy use of loads and shut off power to devices when the device is switched off.
- They save between 15%-25% electricity per year.
- They cost $35-60 per strip

Refer to [this link](http://masssave.com) for more information on which power strips are right for you.
Other Measures To Consider: Advanced Power Strips (cont.)

- Advanced power strips help reduce vampire loads
- Vampire load is the electricity consumed when we have devices on standby mode, or if we forget to turn them off.
Calculating Energy and Cost Savings for These Other Measures

- Use the “Percentage energy savings assumption” tab to get a percentage reduction value for the measure being recommended.
- Calculate the energy use after reduction and directly enter this number into the “Annual energy use after replacement” tab in the “Energy efficiency metrics” section.
Assume a building has 15 desktop computers and 4 vending machines. Calculate the energy use and cost savings with:

- Replacing all the desktops with laptops
- Installing misers in vending machines.
Questions?

www.nrel.gov

NREL/PR-5500-83246
Thank you!

www.nrel.gov