

RETROFIT PROGRAM

Sample Measurement & Verification (M&V) Plan

Lighting Controls

Disclaimer:

- This sample plan is an example for projects installing lighting controls as an energy conservation measure.
- The plan was developed with reference to the Save on Energy Project Measurement and Verification Procedures.
- It is suitable for use as a sample or reference M&V Plan for projects requiring 'Enhanced' M&V through the Save on Energy Retrofit program.
- However, approval of the M&V Plan is at the discretion of the Save on Energy Technical Reviewer.
- Details need to be revised for the specifics of your project.
- This sample M&V Plan is provided for guidance purposes only.
- The savings estimation methodology, input assumptions or other considerations may vary depending on your actual baseline and project details.

1.0 Project Information

Application Identifier

Building Name: ABC Warehouse and Assembly

Building Address: 123 Front St., Pleasantville ON, A1B 2C3

Building Type: Manufacturer/Warehouse

Local Distribution Company (LDC): City Hydro Inc.

Application #: 123,456

This M&V Plan is provided for: Mr. John Doe

Company Name: Corporation of the City of Pleasantville

Company Address: 123 Main St, Pleasantville ON

Contact Information: john@watersidecc.ca

This M&V Plan is provided by: Ms. Jane Smith, CMVP

Company Name: Energy Consulting Inc.

Company Address: 123 Elm Drive, Pleasantville ON, D4E 5F6

Contact Information: jane@energyconsulting.ca

Facility Overview

ABC Warehouse and Assembly is a commercial manufacturing and warehouse building of 17,700 m², which was built in 1986.

Areas of the building are used as office space and for warehouse/assembly and storage.

The building energy use is detailed below.

Exhibit 1: ABC Warehouse and Assembly Energy Use Metrics

ABC Complex	
Energy source	Electricity, natural gas
Reference period	January 1 to December 31, 2016
Energy consumption and demand	Electricity: 34,915 GJ (9,698,888 kWh) Natural Gas: 9,484 GJ (250,303 m ³)
	Summer peak of 900 kW
Energy intensity	2.50 GJ/m ²

A lighting study revealed that there are currently 3,449 F40T12 fluorescent 4' long lamps, with four lamps per fixture.

Currently the lamps are turned on 24/7 with no shut down periods.

The lights are turned on outside of usual operation hours (8:40AM-8:40PM) for occasional warehouse and office use and security reasons.

Exhibit 2: Facility Lighting Inventory

Zone	Area (m²)	Quantity of Fixtures
Office space	7,700	1,449
Warehouse	10,000	2,000

Project Timelines and Dates

Estimated Start Date: July 1, 2018

Estimated Completion Date: July 1, 2019

Note to reader: dates are for illustration purposes only.

2.0 Energy Conservation Measures (ECM) Intent

- The intent of the energy conservation measure (ECM) involves installation of dimming sensors for efficient lighting controls.
- The retrofit project is expected to save about 1,296,652 kWh.
- The incentive amount is estimated at \$64,832.58 based on \$0.05 per kWh.
- Sensors placed on the ceiling will measure lighting intensity (lumens per square foot) and occupancy of the warehouse/office space.
- The lighting controls are outfitted with dimming features and occupancy sensors, which will reduce the number of full capacity operating hours.
- Based on security logs of personnel in an out of the warehouse space, it is anticipated that 12 hours of the day the lights will be dimmed to 50%, and remaining 12 hours at maximum capacity.

Note to reader:

- Non-occupancy lighting control systems are advanced lighting control systems and are incentivized at a rate of \$0.10/kWh.
- Occupancy lighting control systems are standalone lighting control systems such as occupancy sensors and are incentivized at a rate of \$0.05/kWh.
- For more information please contact your Save on Energy Retrofit representative or visit the Save on Energy website.

3.0 Baseline: Period, Energy, and Conditions

This M&V Plan is consistent with industry-wide accepted M&V fundamental principles found in the International Performance Measurement and Verification Protocol (IPMVP) Core Concepts.

Note to reader: The document's full name is "Core Concepts: International Performance Measurement and Verification Protocol (October 2016) EVO 10000 - 1:2016"

IPMVP Option selected (select only one):

- Option A Retrofit Isolation: Key Parameter Measurement
- Option B Retrofit Isolation: All Parameter Measurement
- Option C Whole Facility: Utility Bill Analysis
- Option D Calibrated Simulation

The rationale for selecting Option B is that it is the only option that can accurately measure the energy savings. Option A is not possible because the ECM impacts both the fixture power and operating hours and Option C may require adjustments to the baseline to take upcoming

changes to the cooling system, for instance, into account. The ECM has minimal interactive effects on other building systems.

To reasonably measure the energy savings of this project, fixture power levels will be measured in the baseline and reporting periods, and the operating hours will be quantified by the logged data from the lighting controls system for a duration of two weeks.

Because the ECM can be isolated cost effectively and because a full performance demonstration is required, Option B is the recommended option according to IPMVP Figure 4

The measurement boundary encompasses the electrical power required at a sample of the 3,449 fixtures (ballasts and lamps) subjected to the ECM and the commands sent by the various vacancy, occupancy, and daylight sensors, as illustrated in the following figures.

Figure 1: Wattage measurement boundary

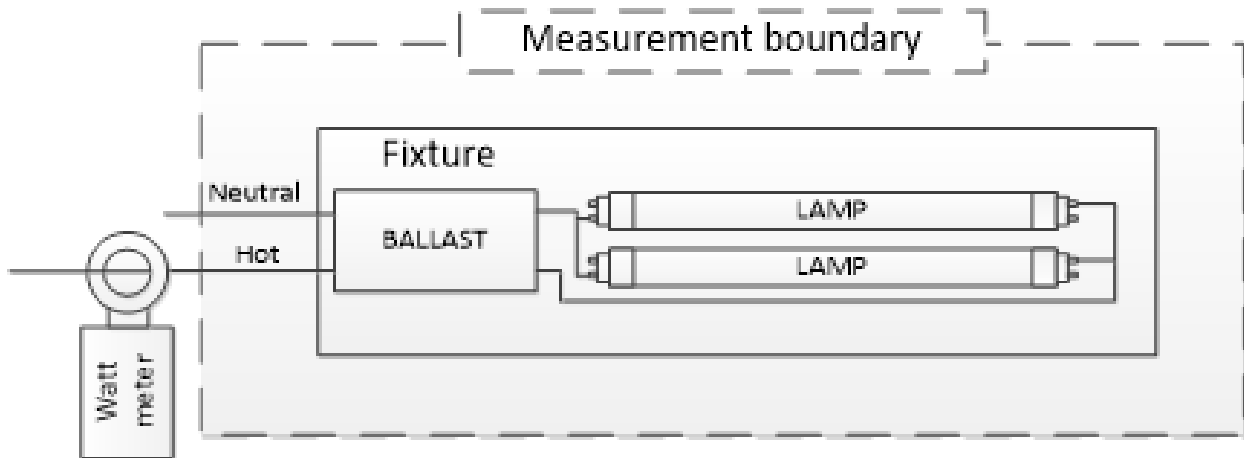
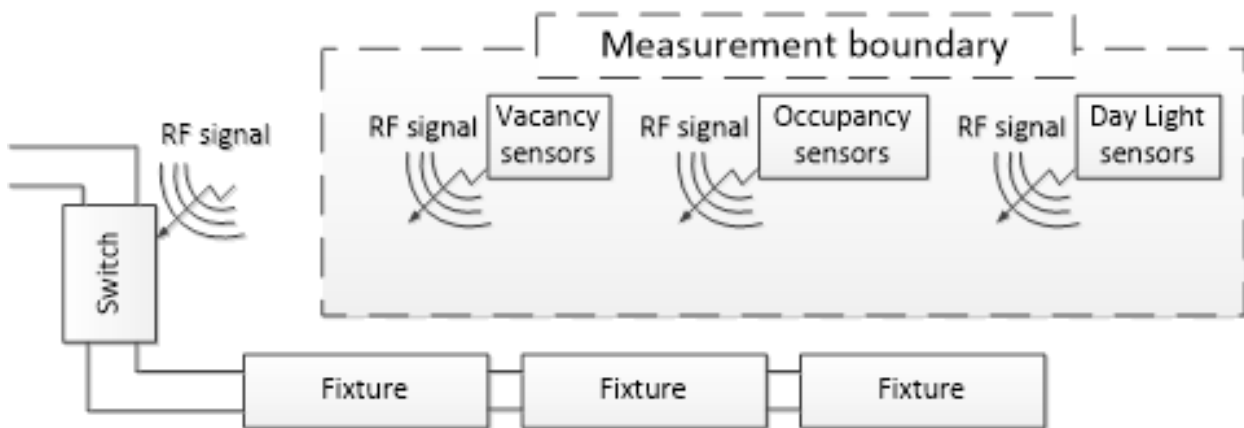


Figure 2: Control measurement boundary



4.0 Baseline: Period, Energy, and Conditions

This section documents the facility's baseline conditions and energy data within the measurement boundary.

Baseline period

The baseline period consists of:

- Spot measurements performed to determine the average kW of the fixture, as well as,
- Continuous measurements for a duration of 2.5 weeks of light intensity to verify the baseline operating hours.

Necessary adjustments to the baseline energy

No adjustment to the baseline is required. The current lighting levels all meet applicable requirements.

Measurement procedure and sampling plan

- The baseline fixture was common across all occupancy areas and had the same occupancy schedule.
- Based on the M&V guidelines for lighting controls projects, 6 sample fixtures were metered to calculate the average baseline kW of the fixture and 5 lux meters were used to verify the operating hours.
- Light levels will be measured by a calibrated light meter to ensure post-retrofit light levels are maintained.
- All vacancy, occupancy and daylight sensor commands for the zone will be recorded by the lighting controls software for two weeks to verify the retrofit case.

Baseline energy consumption and demand:

Exhibit 3: Baseline Electricity Consumption Summary

Zone	Measured Average Fixture Wattage (W)*	Number of Fixtures	Operating Hours from Security Logs (hours)	Consumption (kWh/year)
Office Space	171.7	1,449	8,760	2,179,006
Warehouse	171.7	2,000	8,760	3,007,600
Total		3,449		5,186,606

5.0 Reporting Period

- The reporting period will start at the beginning of the month following the end of the implementation period of the ECM.
- According to the schedule, the reporting period will start on January 1, 2018, and will last for one year after the starting date.
- The reporting period will consist of continuous measurements of the operating hours and instantaneous fixture wattage measurements after ECM commissioning, using the measurement procedure detailed in Section 4.
- The instantaneous light level measurements will be performed and compared to those in the baseline period at the same predetermined locations, as mutually agreed with the customer, at times when lamps are at full output.

6.0 Basis for Adjustment

The avoided energy use adjusted to the conditions of the reporting period approach is used in this M&V Plan.

7.0 Analysis Procedure

The following avoided energy use equation will be used to calculate the monthly energy savings expressed in kWh:

$$E_{Savings} = E_{Baseline} - E_{Reporting}$$

$$E_{Reporting} = \frac{P_{fixture} * Dimming \% * Operation Hours * No of Fixtures}{1000}$$

Where:

E_{Baseline} is the baseline energy consumption in kWh

E_{Reporting} is the reporting period energy consumption in kWh

P_{Fixture} is the measured power consumption (W) of the fixture type.

Operation Hours is the measured reporting period of lighting hours.

Dimming% is the dimming percentage level for the lights.

The following equation will be used to calculate peak demand savings:

$$P_{Savings} = (P_{Baseline} - P_{Retrofit})$$

Where:

$P_{Baseline}$ is the peak monthly baseline load in kW.

$P_{Retrofit}$ is the peak monthly load in kW after the retrofit.

8.0 Meter Specifications

The portable metering equipment for M&V activities includes:

- IRS TES Clamp meter, and a
- Extech Lux meter.

The metering and monitoring equipment will be calibrated against the manufacturer's original specifications or known standards.

The manufacturer's recommended calibration intervals will be used.

Meter	Type	Description	Meter Accuracy	Meter Reading Range	Reading Protocol	Method to Deal with Lost Data
1	Power meter	TES-3063 AC/DC Power Clamp-Meter	± 2% or ± 0.1W	Set to 10 to 500 W	True RMS power measurements	N/A
2	Lux meter	Extech 401025	± 5% or 1 LUX	Set to 200 to 2,000 LUX	1 m above ground at specific locations	N/A

9.0 Monitoring Responsibilities

EP M&V Engineering Consulting has been retained to conduct the power measurements and light level intensity at predetermined locations in the baseline and reporting periods.

Organization	Measurement	
	Data	Frequency
EP M&V Consulting	Fixture wattage	Once before and after the ECM retrofit
EP M&V Consulting	Lux Levels	Once before and after the ECM retrofit

Organization	Independent Variables	
	Data	Frequency
N.A.	No independent variables	N.A.

10. Expected Accuracy

The expected accuracy of this M&V plan, including the accuracy of the instruments and sampling, can be expressed as follows:

Expected sampling accuracy: ±10% accuracy with 90% confidence.

Note to Reader:

- These numbers are set based on industry standards.
- It is expected that meters to be used would be accurate to greater than 10% such that when other sources of uncertainty are accounted for the total accuracy is well within 10%.
- 90% confidence is a threshold taken from the Save on Energy Project Measurement and Verification Procedures.
- Though there is no prescribed confidence level for lighting controls measures, there is a prescribed confidence level for re-lamping lighting measures, and it is 90%.
- Thus 90% is used here.

11. Report Format

The M&V savings report should be prepared as defined by this M&V Plan. EP M&V Engineering Consulting has been retained to prepare the M&V report.

As a minimum, the following sections should be included in the report:

1. The needs of the users of the planned M&V reports.
2. A summary of the physical measurements performed in the baseline and reporting periods, including both the power consumption expressed in kW and light levels expressed in lumens
3. A description and justifications for any corrections made to the observed data.
4. A description and justifications for baseline corrections, including both routine and non-routine.
5. Energy savings calculations expressed in kW or kWh.
6. Input from the review of the report with the facility operating staff.
7. Energy prices are not considered for the cost savings calculations under the saveONenergy retrofit program.

12.0 Quality Assurance

- EP M&V Consulting and the customer agree to share information in preparing the M&V report according to the M&V Plan.
- Without the proper data and structure, the M&V report will be rejected.
- To ensure that all measurements are performed according to the procedure detailed in this document, a representative of the ABC Warehouse and Assembly will be present during all measurements.