efficiency NOVA SCOTIA

Building Optimization Program

Measurement and Verification Guide

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1. Introduction

Measurement and verification is an essential part of the Building Optimization Program as it proves the effectiveness of a project and quantifies the energy savings that are attributed to a project. In order to quantify the energy savings impact of implemented measures within a project, a baseline of energy usage pertaining to these measures prior to their implementation (pre-M&V) must be established, and then compared to a measurement of energy usage following their implementation (post-M&V).

A *Measurement and Verification (M&V) Report* is to be created by the Service Provider following project implementation, and submitted to Efficiency Nova Scotia as a part of the implementation requirements for the Program. The Report should contain the following:

- Description of baseline conditions and final conditions following implementation
- Collected data, and the method of data collection that was used;
- Data collection time periods for baseline measurement and verification of energy savings;
- Clear description of how energy savings are verified;
- Measurement and calculation methods and details;
- All assumptions and sources of data.

1.1. Data Collection Time Period

The data collection time period that is used to establish a baseline of energy usage and verify energy savings should:

- Span over a full operating cycle, from minimum to maximum energy use;
- Be representative of operating conditions of a typical operating cycle;
- Correspond with the periods immediately preceding and following project implementation.

For measures that impact systems that have consistent energy usage week-to-week and are not impacted by weather conditions, a short term data collection period of one week may be sufficient.

For measures that impact systems with energy usage that is highly dependent on weather conditions, a continuous data collection period of one cooling or heating season may be more suitable.

1.2. M&V Methods

The acceptable measurement and verification methods for this Program are based on the International Performance for Measurement and Verification Protocol (IPMVP). The IPMVP is available for download from Efficiency Valuation Organization at www.evo-world.org and can be used as a reference should there be any uncertainty as to which M&V methods are suited to a particular measure or project. The IPMVP offers several different M&V methods that are summarized in the table below.

Table 1: Measurement and Verification Methods

Measurement Methodology	Verification of Energy Savings	Application Example
A. Retrofit Isolation: Key Parameter Adjustment Measurement Energy savings are quantified through field measurements of key performance parameters. Parameters that are not measured are estimated with historical data, engineering judgment, and manufacturers' specifications.	Energy Savings are verified with engineering calculations of energy usage from the measurements and estimated values. Routine and non-routine adjustments are made as necessary.	The operation schedule of a single speed ventilation fan is optimized, where: 1) Power draw is measured over a one week period and 2) Fan operating hours are estimated based on building occupancy schedules.
B. Retrofit Isolation: All Parameter Measurement Energy savings are quantified through field measurements of the energy usage of the system affected by the implemented measures.	Energy Savings are verified with engineering calculations of energy usage from the measurements. Routine and non-routine adjustments are made as necessary.	The set points on a chilled water system are adjusted to increase the efficiency of the system. The electric power of the chiller and associated pumps are measured with a kW meter and portable data loggers. The operating hours and conditions of the system are gathered from trend data from the building

		automation system.
C. Whole Facility Energy savings are quantified by continuous measurements of the energy usage of a whole building or sub-building. Most suitable for projects where energy savings are expected to be greater than 10% of the building's total electrical or fuel usage.	Energy savings are verified with utility data. Routine adjustments as required, using simple comparison or a regression analysis. Non-routine adjustments as required.	The optimization of multiple systems in a building. Baseline energy usage is quantified with utility meter data over a one year period, followed by another year of meter data collection for the verification of energy savings.
D. Calibrated Simulation Energy savings are quantified through the simulation of energy usage of the whole building or sub-building. The methodology behind the simulation is explained. This option takes considerable skills in energy modelling. Most suitable for projects where energy savings are expected to be greater than 10% of the building's total electrical or fuel usage.	Energy savings are verified through simulations, adjusted with hourly and monthly utility billing data.	The optimization of multiple systems in a building, where there is no baseline measurement period. Once installed, utility meter measurements can be used to adjust simulations.

Some examples of key parameters that should be quantified for the measurement and verification of energy savings, based on the system type that a measure is affecting, are listed below. This data can be collected through various activities, including: visual inspection; sample spot measurements; short-term testing; and building automation system control logic and/or trending.

This table serves as a guide only as each project or measure has a unique set of characteristics. Efficiency Nova Scotia can provide data logging equipment to assist with the measurement of some of the parameters that are listed at no charge. With the Customer's written permission, Nova Scotia Power can also provide Efficiency Nova Scotia and other third parties with a billing and meter reading history for the account(s) involved in a particular project.

Table 2: M&V Implementation Methodology Examples

System Type	Stage	Key Parameters
HVAC and Building Automation Systems	Pre	• Weather data; • Building automation set points that are pertinent to project; • Operating schedule and sequence of operation for the portion of system that the measure is impacting. For the equipment that will be affected by the measure, include : • Equipment power usage at full load ; • Equipment efficiency at full load; state efficiencies at representative load levels if the efficiency varies with loading; • Equipment load profile with corresponding hours of operation.
	Post	• Weather data; • Revised equipment and control sequences, set points, operating schedule and load changes, as applicable; • Revised equipment power usage(s);
Lighting Systems	Pre	• Baseline system and/or equipment power usage(s); • Equipment count and their respective wattages from industry references; • Description of lamp/ballast types; • Operating conditions and schedule.
	Post	• Replacement equipment wattage from manufacturer's data sheets and/or industry references, if applicable; • Revised operating conditions and schedule; • Revised system and/or equipment power usage(s).

Plug and Process Loads	Pre	• Baseline system and/or equipment power usage(s); • Equipment load profile with corresponding power usage, collected from building automation system OR from a data logging device; • Operating schedule and sequence of operation.
	Post	• A log of all system changes that were made; • List of equipment replacements that were made, along with manufacturer's data for the new equipment; • Revised system and/or equipment power usage(s).
Air and Water System Balancing	Pre	• Baseline system and/or equipment power usage(s); • Balance report from when the system was last balanced; • System set points that are pertinent to measure; • Operating schedule and sequence of operation for the portion of system that the measure is impacting.
	Post	• A balance report that is completed after measures were implemented; • Revised system set points that are pertinent to measure; • Revised operating schedule and sequence of operation for the portion of system that the measure is impacting; • Revised system and/or equipment power usage(s).

2. Bibliography

Efficiency Valuation Organization. (2014). *International Performance Measurement and Verification Protocol.*