Project Measurement and Verification Procedures

1) Introduction

The objective of measurement and verification (M&V) activities at the Project level is to confirm that the Measures that are supported by the Retrofit Program are installed and resulting in Energy Savings and Demand Savings.

This protocol will assist the IESO and their Project Evaluators as well as Participants in selecting approaches and methods for estimating Energy Savings and Demand Savings of Projects with Custom Measures. Results can also be used to support:

- Good energy management practices by program participants
- The determination of cost-effectiveness of projects

The challenge is to balance M&V costs, savings certainty, and the value of the conservation measure.

2) Methods

Project Measurement and Verification (M&V) Procedures shall be consistent with IPMVP Protocols. IPMVP Protocols means the International Performance Measurement & Verification Protocol (IPMVP) – Core Concepts June 2014 EVO 10000 – 1:2014, and Statistics and Uncertainty for IPMVP June 2014 EVO 10100 – 1:2014 or later as in effect from time to time. See www.evo-world.org

Four generic M&V options can be employed:

A) Engineering calculations (using both stipulated values and measurements)

B) Metering and monitoring (spot, short term, or continuous measurements)

C) Utility bill analysis

D) Computer simulation models.

Considerations in selecting the M&V option include:

- Complexity of the Measure
- Potential for changes in key factors that affect the baseline and post retrofit conditions
- The Measure's savings value
- The Measure's cost and associated Participant Incentive

Option A and **B** are applied at the *Measure* or *system* level.

Option C is applied at the *whole building* level.

Option D is applied at either the whole building or Measure level.

When M&V is applied at the ***Measure*** the primary considerations are:

1) Is the load constant (e.g. lighting fixture) or variable (e.g. VSD applied to a fan)

2) Are the operating hours constant (e.g. garage lighting) or variable (e.g. cooling hours)

Spot measurements can suffice for constant loads, whereas short term or continuous measurements may be required for variable load.

Where operating hours are constant, stipulated values can be applied, subject to validation. Where operating hours are variable, short term or continuous measurement may be required.

Differentiate M&V first by the type of project:

1) **Custom projects - equipment retrofit only**, where efficiency gains are achieved by the retrofit or replacement of equipment, without changes in operations.

2) **Custom projects - operational change only**, where energy consumption (and possibly demand) is reduced by changing the operating periods, settings or methods, without modifications to the equipment.

3) **Custom projects - equipment retrofit and operational change**, where the combination of equipment and operational changes may impact load and energy separately or energy directly.

4) **Custom projects - multiple energy conservation measures (ECMs)**, where three or more ECMs are implemented at a single site or facility. Multiple ECM's may enable the use of whole facility metering to determine savings.

M&V efforts will vary according to:

- Savings size (projected savings and potential incentive)
- Savings uncertainty (doubt about likely result of the measure's activity)
- For 'small' and 'certain' projects, 'least M&V effort' will involve acceptance of stipulated kW or kWh values, subject to reasonableness and validity checks, relative to industry norms.
- For 'large' and 'uncertain' projects, the 'highest M&V effort' will involve more rigorous scrutiny of baseline conditions specific to the facility, involving spot or short term measurements on all, or a representative sample, of loads or operating hours as applicable.
- Extended post retrofit monitoring is not generally contemplated. (Extended monitoring may be done for other purposes, but will not be a condition of incentive payment, except if it is a specific condition of the accepted Project M&V Plan for a particular project.)
- Where available, existing data, as obtained through sub-metering, BAS logs, etc., will be utilized to the fullest extent, and will be considered as greatly enhancing the quality of the M&V.
- Enhanced M&V efforts undertaken by the Participant, including the use of existing monitoring data can be used to support savings claims (subject to acceptability of the data quality).
- Measures with a high degree of savings uncertainty will be conservatively discounted with an option (and onus) for Participants to prove greater savings through extended pre and/or post–retrofit monitoring.

As it relates to projects being evaluated under the Retrofit Program:

- M&V will be applied at the Measure and system level.

- In general, Options A and B will normally be employed – i.e. using a combination of stipulated values (referenced to industry standards or agreed site operating conditions), spot and short-term measurements.
- M&V will ensure diligence in establishing the baseline conditions and in defining the requirements for confirmation of post-retrofit savings.
- All measures will be required to report Energy and Demand Savings.
- Project M&V Procedures are subject to continuous improvement, consistent with the principles described here, as program experience and empirical data are gained.

3) Project M&V Procedures by Eligible Measure

The following table lists the Project M&V Procedures to be applied according to:

- Type of Custom Measure
- Estimated Participant Incentive for the Custom Measures

Demand Savings (kW) are the average load reduction in electricity demand between the Base Case and the Energy Efficient Case occurring in between 1 pm to 7 pm on business days, June 1 through August 31 as shown below. Refer to 'Conservation First (2015-2020) EM&V Protocols and Requirements' for more details on Standard Definition of peak for calculating demand Savings at http://www.powerauthority.on.ca/opa-conservation/conservation-information-hub/evaluation-measurement-verification (Page 75 - 79)

Energy Savings (kWh) are those electricity savings achieved over the course of the first year after the completion of a Project.

Generally,

'**Basic**' M&V will be used for Large Project that include Custom Measures with estimated Participant Incentives greater than $10,000 and equal to or lesser than $40,000. A 'Basic' M&V Plan should be developed for each Large Project by a qualified professional and should consist of the following sections. Please refer to Appendix C for a generic 'Basic' M&V Plan template:

1) Project General Information
2) Energy Conservation Measures (ECM) Intent
3) Baseline: Period, Energy and Conditions
4) Basis for Adjustment
5) Analysis Procedure
6) Report Format

'**Enhanced**' M&V will be used for Large Custom Projects. Large Custom Project means a Project with Custom Measures that has an estimated Participant Incentive greater than $40,000. An 'Enhanced' M&V Plan in complete adherent to the IPMVP Protocol Core Concepts June 2014 EVO 10000 – 1:2014 and Statistics and Uncertainty for IPMVP June 2014 EVO 10100 – 1:2014 or later should be developed for each Large Custom Project by a qualified professional such as a Certified M&V Professional (CMVP), and should consist of the following sections. Please refer to Appendix C for a generic 'Enhanced' M&V Plan template:

1) Project General Information
2) Energy Conservation Measures (ECM) Intent
3) Selected IPMVP Option and Measurement Boundary
4) Baseline: Period, Energy and Conditions
5) Reporting Period

6) Basis for Adjustment
7) Analysis Procedure
8) Energy Prices
9) Meter Specifications
10) Monitoring Responsibilities
11) Expected Accuracy
12) Budget
13) Report Format
14) Quality Assurance

The table below identifies the Project M&V Procedure to be used dependent on the Custom Measure Type and whether Basic or Enhanced M&V is required.

Table 1: Selection of M&V Procedures (Ctrl+Click to follow link)

#	Custom Measure Type	M&V Procedure	
		'Basic'	'Enhanced'
1	Lighting Retrofit	LR-B	LR-E
2a)	Equipment Replacement – Chillers	ERC-B	ERC-E
2b)	Equipment Replacement – Refrigeration	ERR-B	ERR-E
2c)	Equipment Replacement – Motors	ERM-B	ERM-E
2d)	Equipment Replacement – Air Compressors	ERAC-B	ERAC-E
2e)	Equipment Replacement – Aeration Blowers	-	ERAB-E
3	HVAC Redesign	-	HVAC-E
4	Variable Speed Drives (VSDs)	VSD-B	VSD-E
5	Building Envelope	BE-B	BE-E
6	Building Automation Systems (BAS)	BAS-B	BAS-E
7	Lighting Controls	LC-B	LC-E
8	Tenant Sub Metering (TSM)	-	TSM-E
9	Monitoring and Targeting (M+T)	-	MT-E
10	Other Custom Measures	-	OCM
11	Power Conditioning Devices	-	PCD-E

Measure specifics 'Basic' M&V guidelines for individual measure shown in Table 1 above, refer to Appendix A or use the hyperlink provided (Ctrl + Click to follow the link)Measure specifics 'Enhanced' M&V guidelines for individual measure shown in Table 1 above, refer to Appendix B or use the hyperlink provided (Ctrl + Click to follow the link)

Generic 'Basic' and 'Enhanced' M&V Plan templates can be found in Appendix C. This M&V template can be used by the Applicant or Applicant Representative as the basis for submitting the M&V Plan and Saving Report. This template lays out the minimum information required by the IESO to enable their review of the application. The template is provided to help maintain consistency in documenting the information with regards to Large Projects with Custom Measures or Large Custom Projects. Participants are encouraged to provide any additional information related to Project Measurement and Verification (M&V) procedures as required.

A library of sample M&V Plans are available as example only in assisting to Applicant or Applicant Representative in completing the M&V Plan for their project. These sample plans present Core Principles adherent to the IPMVP Protocol. However, each project must be individually designed to suit the objectives and desired accuracy of energy saving efforts. This individual design is recorded in the project's M&V Plan and savings are reported as defined by that M&V Plan, which should be developed for each project by a qualified professional such as a Certified M&V Professional (CMVP). This library is maintained and updated from time to time.

APPENDIX A: 'Basic' M&V Guidelines

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Measure #1 - Lighting Retrofit LR-B

- Stipulation of operating hours for determination of Energy Savings is acceptable using existing operating logs or documents schedules, subject to validity checks.
- Baseline wattage established from industry references to the various lamp/ballast types installed.
- Post-retrofit wattage is to be established from manufacturer's data sheets (to be provided with application) and/or industry references.
- Participant should provide detailed site surveys that include inventory of lamp/ballast fixture type by area, usage area designation and operating periods (e.g. common space 7x24; tenant space – lease hours) and counts of operating and non-operating fixtures and lamps.

Measure #2 - Equipment Replacement

- Whether load is constant or variable, refer to manufacturers' data and industry references for kW ratings at various load points.
- Assumptions for operating profile, both load and operating hours, to be reviewed by Project Evaluator for reasonableness.
- Participant to provide detailed inventory of all equipment, baseline and proposed post-retrofit, showing quantities, thermal and electrical ratings.

2a) Chillers ERC-B & 2b) Refrigeration ERR-B

- Use stipulated values, at 80% of nameplate capacity of operating equipment, of baseline and post retrofit kW, Baseline kW shall assume OEM rated of shop tested efficiency. In cases where the retrofit nameplate capacity is different from the baseline nameplate capacity (i.e. "right-sizing" of equipment), declare the set of conditions to which baseline energy will be adjusted as per Core Concepts of IPMVP Protocol.
- Energy Savings determination - Use manufacture ratings for baseline and post-retrofit kW at representative distributed load levels spanning total capacity, multiplied by stipulated operating hours at each point.
- Exclude chiller auxiliary equipment (pumps and cooling tower) unless this equipment is changed as well.

2c) Motors ERM-B

- Energy Savings determination - Use stipulated values for efficiency and power factor, at 80% load, using manufacturer ratings. Energy Savings = Demand Savings x stipulated operating hours.
- If variable load, stipulate efficiency and power factor at representative load levels, and stipulate hours at each level.

2d) Air Compressors ERAC-B

- Energy Savings determination - Use CAGI data sheets for baseline and post-retrofit kW at representative distributed load levels spanning total capacity, multiplied by stipulated operating hours at each point. Airflow in ACFM can be stipulated, as obtained from CAGI data sheets
- In the absence of CAGI data sheet, Baseline performance is to be measured. Measured parameters include power (kW) or voltage, amperes and power factor.
- Continuous interval Measurement should be conducted to reflect typical operating cycle – e.g. Monday to Friday, a full working week.
- Retrofit case flow and power consumption is to be measured by the same method as the Baseline measurement.

Measure #4 - Variable Speed Drives (VSDs) VSD-B

- Load is likely constant for baseline, variable (by definition) post retrofit.
- Refer to manufacturers' data, industry references, for kW ratings at various load points.
- Stipulate baseline motor efficiency and power factor if baseline is constant; stipulate efficiency and power factor at representative load levels if baseline is variable; stipulate operating hours at each level.
- Assumptions of operating profile both load and operating hours, will be reviewed for reasonableness.

Measure #5 - Building Envelope BE-B

- Involves consideration of cooling efficiency in assessing summer savings.
- Refer to manufacturers' data, industry references, for thermal or leakage properties.
- Stipulated values for cooling kW/ton
- Stipulated values, derived from detailed simulation modeling provided by the manufacturer of the installed product for typical buildings. The model shall account for actual glazing types, and actual building envelope features, shading, orientation and normal local weather. The model shall be adjusted to the specific site conditions.

Measure #6 - Building Automation System (BAS) BAS-B

- Recognized as inherently uncertain.
- May be a new BAS installation or an enhancement of an existing system.
- Provide detailed description of baseline and post-retrofit operating conditions, with anticipated savings.
- Provide operating logs or other monitoring data to support claimed operating conditions.
- Discount savings that have supporting baseline data by 25%
- Discount savings that have no supporting baseline data by 50%

Measure #7 - Lighting Controls LC-B

- Recognized as inherently uncertain.
- May be a new installation or an enhancement of an existing system.
- Provide detailed description of baseline and post-retrofit operating conditions, with anticipated savings.
- Provide operating logs or other monitoring data to support claimed operating conditions.
- Discount savings that have supporting baseline data by 25%
- Discount savings that have no supporting baseline data by 50%

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APPENDIX B: 'Enhanced' M&V Guidelines

Measure #1 - Lighting Retrofit LR-E: Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Provide Inventory of existing lamps, fixtures, and ballasts affected including fixture, lamp and ballast types, operating log (e.g. common space 24/7; tenant space lease hours), usage area designation, counts of operating and non-operating fixtures and lamps* **Reporting of non-operating fixtures is required and should be limited to 10% of total number of fixtures. If there is more than 10% of non-operating fixture, these should be excluded from the project.*
Proposed System Description	Inventory of Retrofit lamps, fixtures, and ballasts affected including fixture, lamp and ballast types, operating log (e.g. common space 24/7; tenant space lease hours), usage area designation, counts of operating and non-operating fixtures and lamps
Measurement Boundaries	For power measurements, include only those equipment (i.e. fixtures, lamps) types selected as per Sampling protocol within measurement boundaries. Measurement boundary should include all the fixtures being replaced as per Project Scope
Measurement Conditions	Post Retrofit measurements should allow for a minimum 100 hours of burn–in A statistically significant sample of fixtures as per Sampling protocol should be measured
Sampling	Representative sampling to be followed for the selection of samples. Sampling is to be distributed across the facility. The measurement data should be collected for each fixture usage group. Measurement data should be obtained for a sample of loads (Sampling size determination is typically 90% Confidence and ±10% Precision for each homogeneous population) for both Baseline and Retrofit for each type of fixtures. Selecting the appropriate sampling criteria requires balancing accuracy requirement with M&V costs within the budget it may be appropriate to establish a maximum sample size in the M&V Plan. If this maximum is actually reached after the re-computations, the saving report should note the actual precision achieved by the sampling.
Baseline Period and Reporting Period Duration	Installation report is required to substantiate burn-in hours (100 hours). Operating hours logging is required for Large Custom Projects to validate operating hours. Retrofit measurements for Lighting Measure wattages should allow for a minimum 100 hours of burn-in hours.
Metering Requirements	In cases where measurements are not commercially reasonable, fixture wattages should be stipulated using Standard Lighting Tables or manufacturer's data sheets available Spot metering should be conducted for Retrofit fixtures using the same methods and procedures used for the Baseline fixtures. Metering to be conducted for both RMS wattage and/or operating hours (manual or metered) For lighting retrofit projects with financial incentive amount greater than $40,000 and less than $80,000, IPMVP M&V Option A should be used and for incentive amount greater than or equal to $80,000, IPMVP M&V Option B should be used. <u>Metering Instructions for both Baseline and Retrofit:</u> *(1) Metering of Fixture Wattages:* Requires the use of RMS meter, continuous monitoring on a sample population within each usage group, the readings should be averaged and calibrated Meters should be used. *(2) Logging Operating Hours:* Continuous monitoring (manual or metering) on a sample population within each usage group should be conducted for a minimum of one week or span across full operating cycle. When seasonal variations or scheduled activity affect equipment operation, metering should be conducted during each variation period. (e.g. summer operating schedules in classrooms). Metering period should not include vacations or holidays.
Demand Savings Calculation	Refer to EM&V's protocol for demand saving definition $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$

Required Parameters	M&V Guidelines
Energy Savings Calculation	If Baseline and Retrofit Operating hours are the same: $kWh_{Savings} = (kW_{Baseline} - kW_{Retrofit}) \times Op\ Hrs$ If Baseline and Retrofit Operating hours vary: $kWh_{Savings} = (kW \times Op\ Hrs)_{Baseline} - (kW \times Op\ Hrs)_{Retrofit}$ Operating hours should be logged for at least one week to establish an operating schedule for each usage group. Operating hours can be assumed to be constant during each season.
Baseline Adjustments	Baseline Adjustments are required in the case that quantity, lighting level and operating hours are reduced significantly (typically more than 30%)

Measure #2a) - Equipment Replacement: Chillers ERC-E Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Baseline information of existing equipment including chiller nameplate data, load served, efficiency ratings, operating schedule and equipment location
Proposed System Description	Baseline information of existing equipment including chiller nameplate data, load served, efficiency ratings, operating schedule and equipment location
Measurement Boundaries	Measurements to be taken at Measure level and should include equipment that will be retrofitted
Measurement Conditions	Baseline metering is normally performed during a period where a range of cooling loads exists (e.g. summer). Baseline and Retrofit performance is to be measured at representative distributed load levels spanning total design loads, multiplied by stipulated operating hours at each point.
Sampling	Samples should span across different load levels with minimum of 20% sample across the different load levels.
Baseline Period and Reporting Period Duration	Continuous interval measurements are to be made to reflect full cycle of operation of Baseline and Retrofit chiller for a minimum of 1 week.
Metering Requirements	Multiple measurements are made while the cooling systems are operating at different loads so that the complete range of chiller performance can be evaluated Metering to be conducted for both continuous interval metering of chiller kW using true RMS meter and cooling load using a BTU meter or monitoring of supply and return chilled water temperature and chilled water flow rate.
Demand Savings Calculation	Refer to EM&V's protocol for demand saving definition $kW_{Savings} = (kW_{Baseline} - kW_{Retrofit})$
Energy Savings Calculation	$kWh_{Savings} = (kWh_{Baseline} - kWh_{Retrofit}) \pm Routine\ Adjustment \pm Non\ Routine\ Adjustment$ $kWh_{Baseline}$ is the Baseline energy consumption totaling the sum of the energy consumption for each hour of the year (kWh) $kWh_{Retrofit}$ is the Retrofit energy consumption totaling the sum of the energy consumption for each hour of the year (kWh)
Baseline Adjustments	Baseline Adjustment is required when Retrofit cooling load is significantly different from the measured Baseline cooling load. Baseline should be adjusted to the Reporting Period conditions using CDD, HDD or rate of production.

Measure #2b) - Equipment Replacement: Refrigeration ERR-E Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Baseline information of existing equipment required refrigeration unit nameplate data, load served, efficiency ratings, operating schedule and equipment locations
Proposed System Description	Baseline information of existing equipment required refrigeration unit nameplate data, load served, efficiency ratings, operating schedule and equipment locations
Measurement Boundaries	Measurements to be taken at *Measure* level and boundaries should include equipment that will be retrofitted
Measurement Conditions	Baseline and Retrofit performance is to be measured at representative distributed load levels spanning total design loads, multiplied by stipulated operating hours at each point.
Sampling	Sampling should be carried out as per IPMVP protocol
Baseline Period and Reporting Period Duration	Continuous interval measurements are to be made to reflect full cycle of operation of existing and retrofit units for a minimum of 1 week.
Metering Requirements	Metering to be conducted for both continuous interval metering of Refrigeration kW and metering of Cooling Load
Demand Savings Calculation	Refer to EM&V's protocol for demand saving definition $kW_{Savings} = (kW_{Baseline} - kW_{Retrofit})$
Energy Savings Calculation	$kWh_{Savings} = (kWh_{Baseline} - kWh_{Retrofit}) \pm Routine\ Adjustment \pm Non\ Routine\ Adjustment$ $kWh_{Baseline}$ is the Baseline energy consumption totaling the sum of the energy consumption for each hour of the year (kWh) $kWh_{Retrofit}$ is the Retrofit energy consumption totaling the sum of the energy consumption for each hour of the year (kWh)
Methodology Applied for Variable Load	Continuous interval kW measurement required at various load levels

Measure #2c) - Equipment Replacement: Motors ERM-E Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Provide Inventory of existing motors affected including nameplate data, motor horsepower, quantity, load profile, operating schedule and motor application
Proposed System Description	Provide Inventory of existing motors affected including nameplate data, motor horsepower, quantity, load profile, operating schedule and motor application
Measurement Boundaries	Measurement boundaries should include all motors that will be replaced and including all dependent and independent variables
Measurement Conditions	A statistically significant sample of motors should be measured
Sampling	In case of multiple motor replacements, sampling is to be done on the type of load they serve by usage groups. For projects in which a large number of equal-sized motors and same operating hours, metering can be conducted on a sample of motors and the results can be extrapolated to the population Measurements should be made on the lesser of 30 motors or 10% of the population. This should be applied to each usage group of comparable load application
Baseline Period and Reporting Period Duration	Metering observation should be made for both Baseline and Retrofit in 15 minute intervals for variable or constant load respectively and should span a full operating cycle from maximum to minimum energy.
Metering Requirements	In cases where measurements are not practically possible, kW should be stipulated using manufacturer's datasheets or nameplates. Where metering is required, spot metering should be conducted for Retrofit motors using the same methods and procedures used for the Baseline motors. Metering is required for both spot/short term power measurements and operating hours Metering Instructions: *(1) Power Consumption Measurements (kW)* - For constant load motors, spot or short-term measurements on a sample population within each usage group should be conducted to obtain three-phase amps, volts, Power Factor, kW, and RPM. Multiple spot measurements at each load level are required for variable load application. *(2) Logging Operating Hours* - Continuous monitoring on a sample population within each usage group should be conducted for a minimum of one week or span across full operating cycle. When seasonal variations or scheduled activity affect equipment operation, metering should be conducted during each variation period. Metering period should not include vacations or holidays.
Demand Savings Calculation	Refer to EM&V's protocol for demand saving definition $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ $kW_{Baseline}$ and $kW_{Retrofit}$ to be collected in 15 minute intervals for variable or constant load respectively. A continuous interval measurement of kWBaseline and kWRetrofit is required.
Energy Savings Calculation	For same operating hours: $kWh_{Savings} = (kW_{Baseline} – kW_{Retrofit}) \times Op\ Hrs$ For different operating hours: $kWh_{Savings} = (kW \times Op\ Hrs)_{Baseline} – (kW \times Op\ Hrs)_{Retrofit}$ Operation hours should be logged for one operating cycle to establish an operating schedule for each usage group. The data can be then extrapolated for whole year with adjustment for seasonal variation. For motors with seasonal load patterns, the average operating hours should be weighted according to relative length of each seasonal period

Measure #2d) - Equipment Replacement: Air Compressors ERAC-E Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Baseline information of existing equipment including compressor nameplate data, CFM at full load, Voltage, Amps (FLA), Amps (LRA), pressure, age, operating schedule and conditions, equipment location, type (reciprocating, rotary screw, etc.), operation type (modulating, load/unload,etc.), annual operating hours.
Proposed System Description	Baseline information of existing equipment including compressor nameplate data, CFM at full load, Voltage, Amps (FLA), Amps (LRA), pressure, age, operating schedule and conditions, equipment location, type (reciprocating, rotary screw, etc.), operation type (modulating, load/unload,etc.), annual operating hours.
Measurement Boundaries	Measurements to be taken at *Measure* level. Measurement boundaries should include equipment and other accessories that will be Retrofitted.
Measurement Conditions	Baseline and Retrofit performance is to be measured in 15 minute continuous interval measurements to represent the full operating cycle.
Sampling	Samples should span across different load levels. Minimum of 20% sample across the different load levels
Baseline Period and Reporting Period Duration	Continuous interval Measurement should be conducted to reflect typical operating cycle – e.g. Monday to Friday, a full working week.
Metering Requirements	Measured parameters include power (kW) or voltage, amps, power factor and airflow load (CFM), and/or pressure. For Retrofit, Power (kW) and design load (CFM) are to be measured and compared with Baseline measurement. If the process flow is significantly different, Baseline adjustment should be made to reflect the Retrofit conditions. .
Demand Savings Calculation	Refer to EM&V's protocol for demand saving definition. $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ Baseline performance is to be measured and/or simulated by using stipulated values (nameplate data, manufacturer specifications, etc.). Measured parameters include power (kW) or voltage, amps, power factor and airflow load (CFM), and/or pressure. Measurement should be conducted to reflect typical operating cycle – e.g. Monday to Friday, a full working week. Retrofit case performance is to be measured by the same method as the Baseline measurement. Power (kW) and design load (CFM) are to be measured and compared with Baseline measurement.
Energy Savings Calculation	Energy Consumption (kWh) may be calculated by multiplying average demand (kW) by operating hours. $kWh_{Savings} = (kWh_{Baseline} - kWh_{Retrofit}) \pm Routine\ Adjustment \pm Non\ Routine\ Adjustment$ Operating hours are required to be logged (manual or monitor). Operating logs and other documents may be used to support the operating hours.
Baseline Adjustments	In case where the design load (CFM) is significantly different between Base and Energy Efficient Case, the measurement may be normalized. The normalization may be taken in the Retrofit stage as the Savings may be subject to change based on the Energy Efficient case measurement. Regression analysis (kW vs. CFM) is required for normalization. Baseline Adjustment Calculation *Baseline Efficiency [kW/CFM] = Baseline Peak Demand [kW] ÷ Baseline Average Airflow Load [CFM]* *Adjusted Baseline Demand [kW] = Baseline Efficiency [kW/CFM] x Retrofit Case Average Airflow [CFM]* Savings Calculation after Adjustment *Demand Savings [kW] = Adjusted Baseline Demand [kW] – Retrofit case Demand [kW]* *Annual Savings [kWh] = Adjusted Baseline Consumption [kWh] – Retrofit case Consumption [kWh]*

Measure #2e) - Equipment Replacement: Aeration Blowers ERAB-E Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Baseline information of existing equipment including manufacturer/Model Number, HP, load, voltage, amps, constant speed/variable speed, and annual operating hours
Proposed System Description	Baseline information of existing equipment including manufacturer/Model Number, HP, load, voltage, amps, constant speed/variable speed, and annual operating hours
Measurement Boundaries	Measurements should be taken at Measure e.g. blowers, level and boundaries should include equipment that will be replaced.
Measurement Conditions	A minimum of 1-week monitoring period representative of the typical blowers' operating schedule or a typical full cycle of operation.
Sampling	Samples should span across different load levels. Minimum of 20% sample across the different load levels.
Baseline Period and Reporting Period Duration	Utility bill comparison analysis is recommended for when blowers represent 50% or more of the total facility electrical Energy Consumption. Establish a regression model compiling utility meter data and historical wastewater flow volume as independent variable for the Baseline Period.
Metering Requirement	Measured parameters include power (kW) or voltage, amps, power factor and airflow (CFM), and/or pressure at 15-minutes interval for a minimum of one week. If the process flow is significantly different, Baseline adjustment should be taken to adjust the Savings.
Demand Savings Calculation	The following equations will be used to calculate Demand Savings. It is required that 15-minute-interval data covers the peak demand period for both pre- and post- installation. Refer to EM&V's protocol for demand saving definition. Refer to EM&V's protocol for peak demand and demand saving definition. $$[\boldsymbol{kW}_{\boldsymbol{savings}}] = \boldsymbol{kW}_{\boldsymbol{Adj\_Baseline}} - \boldsymbol{kW}_{\boldsymbol{Retrofit}}$$
Energy Savings Calculation	Energy Savings is calculated comparing utility metered data in post-retrofit with the adjusted Baseline energy consumption. The following equations will be used to calculate Energy Savings: $$[\boldsymbol{kWh}_{\boldsymbol{savings}}] = \boldsymbol{kWh}_{\boldsymbol{Adj\_Baseline}} - \boldsymbol{kWh}_{\boldsymbol{Retrofit}}$$ $kWh_{Adj\_Baseline}$= Total annual Energy Consumption Baseline model as determined by the regression analysis for pre-Retrofit billing data and correlated to the Retrofit wastewater flow volume. $kWh_{Retrofit}$= Total annual Energy Consumption as reported in utility billing data after the Retrofit installation
Baseline Adjustments	Perform non-routine Baseline Adjustment when Retrofit wastewater effluent is significantly different from those recorded in the Baseline Period. A regression model should be established to calculate the adjusted Baseline with the Retrofit wastewater effluent in the Reporting Period. A minimum of R-squared (R^2) statistic of greater than 75% should be used. R-squared is a statistical measure of how close the data are to the fitted regression line.

Measure #3 – HVAC Redesign HVAC-E Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Inventory of Baseline equipment affected. Baseline information of all components in HVAC system to be studied including but not limited to HVAC equipment (refrigeration units, AC units, fans, etc.), Location – weather bin data, HDD, CDD, Cooling/heating load and Operating schedule
Proposed System Description	Inventory of Baseline equipment affected. Baseline information of all components in HVAC system to be studied including but not limited to HVAC equipment (refrigeration units, AC units, fans, etc.), Location – weather bin data, HDD, CDD, Cooling/heating load and Operating schedule
Measurement Boundaries	Measurement boundaries should include all components within the HVAC system and any other auxiliary components that are affected by the proposed re-design. Measurements to be taken at system level Component Measure within the HVAC Re-design is to be considered separately and in isolation, to the extent practical
Measurement Conditions	Measurement conditions should be comparable between Baseline and Retrofit case (e.g. operating profile, time and duration of measurement, measured parameters, equipment, etc.)
Sampling	For project that involves other Measure combined with replacement of HVAC units sampling can be excluded for HVAC units
Baseline Period and Reporting Period Duration	Reporting duration should cover full operating profile of the system and the result is to be compared with engineering references (manufacturer specifications of equipment, reasonable and practical operating hours
Metering Requirements	Metering to be conducted will require short and/or long-term continuous interval measurements Continuous interval measurements are to be made to reflect full cycle of operation of all components of the existing and re-designed HVAC system performance The measurement method/approach for both Baseline and Retrofit should be comparable (e.g. time, method, etc.).
Demand Savings Calculation	Refer to EM&V's protocol for peak demand and demand saving definition $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ Continuous interval measurements to be used to establish Baseline. Demand Savings is to be determined by measured peak Demand for Baseline and Retrofit case. Output load such as cooling/heating load should also be considered according to the type of proposed redesign
Energy Savings Calculation	Energy Savings, kWh can be calculated by Baseline kW multiplied by operating hours. The operating hours may be estimated by extrapolating from measurement period. $kWh_{Savings} = (kWh_{Baseline} – kWh_{Retrofit}) \pm Routine\ Adjustment \pm Non\ Routine\ Adjustment$
Baseline Adjustments	Baseline Adjustments should be made based on Operating Profile, cooling and heating load, weather data (location, HDD, CDD)
Methodology Applied for Variable Load	For various load, continuous interval measurement should be performed for kW at various load and/or use engineering reference. Output such as airflow rate, cooling and heating load are also to be measured and studied to establish kW at each representative load.

Measure #4 – Variable Speed Drives (VSDs) VSD-E Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Inventory of Baseline equipment affected. Baseline information of existing equipment including Nameplate data, Motor horsepower, Quantity, Load served, Operating schedule, Motor application, Location, Spot-metering data for a Baseline sample that is representative of each usage group
Proposed System Description	Inventory of Baseline equipment affected. Baseline information of existing equipment including Nameplate data, Motor horsepower, Quantity, Load served, Operating schedule, Motor application, Location, Spot-metering data for a Baseline sample that is representative of each usage group
Measurement Boundaries	Measurement boundary should include all existing equipment that will be Retrofitted with VSD(s). The measurement boundary should capture all existing equipment and not only those that are selected to be representative samples during measurements.
Measurement Conditions	Measurements should be conducted to include all operating parameters and to reflect the various operating points
Sampling	Baseline equipment should be grouped into usage groups according to those with identical operating characteristics and/or expected operating hours. The lesser of 30 or 10% of the existing equipment from each usage group should be subject to metering where measurements are required For projects in which a large number of equal-sized motors with the same application and operating schedule will be replace, metering may be conducted on a sample of motors and the results extrapolated to the applicable population.
Baseline Period and Reporting Period Duration	Reporting duration should span through a full operating cycle in both Baseline and Reporting periods. A typical operating cycle should reflect the highest and lowest consumption and various operating points.
Metering Requirements	Metering to be conducted for both motor power draw to be defined using continuous-metering at each motor load level. Operating hours to be logged for each load levels. <u>Metering Instructions:</u> For both Baseline and Retrofit: *(1) Power Consumption Measurements (kW)* • For constant load motors, spot or short-term measurements on a sample population within each usage group should be conducted to obtain three-phase amps, volts, Power Factor, kVA, kW, and RPM. • Multiple spot measurements at each load level are required for variable load application. *(2) Logging Operating Hours* • Continuous monitoring on a sample population within each usage group should be conducted for a minimum of two weeks or span of full operating cycle. • When seasonal variations or scheduled activity affect equipment operation, metering should be conducted during each variation period. (e.g. HVAC system motors should be measured during summer peak months). • Metering period should not include vacations or holidays.
Demand Savings Calculation	Refer to EM&V's protocol for demand saving definition • Baseline Demand is assumed to stay constant into Retrofit stage, as Baseline and Retrofit equipment are not changed • In the case where there are multiple usage groups, Demand is the sum of $kW_{usage\ group}$: $kW_{usage\ group}$ = *(kW/Motor) x (Motor Quantity in Usage Group)* This equation applied to both Baseline and Retrofit calculations. Motor quantities and number of usage groups should remain constant. If these values change, refer to Baseline Adjustment.

Required Parameters	M&V Guidelines
	$kW_{Baseline} = kW_{Baseline\ usage\ group}$ x $(\#\ of\ usage\ groups)_{Baseline}$ $kW_{Retrofit} = kW_{Retrofit\ usage\ group}$ x $(\#\ of\ usage\ groups)_{Retrofit}$ $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$ Measurements of $kW_{Baseline}$ and $kW_{Retrofit}$ to be collected in 15-min interval RMS metering wattage measurements.
Energy Savings Calculation	If Baseline and Retrofit Operating hours are the same: (1) $kWh_{Savings} = (kW_{Baseline} - kW_{Retrofit})$ x Stipulated Op Hrs If Baseline and Retrofit Operating hours vary: (2) $kWh_{Savings} = (kW\ x\ Op\ Hrs)_{Baseline} - (kW\ x\ Op\ Hrs)_{Retrofit}$ Baseline and Retrofit hours of operation should be logged to establish an operating schedule for each usage group. $Stipulated\ Op\ Hrs = \frac{Motor\ ON\ during\ Metering\ Period\ (hrs)}{Length\ of\ Metering\ Period\ (hrs)} \times 8760\ \frac{hrs}{year}$
Baseline adjustments	Baseline Adjustments are required in the case that there are non-operating motors in the Post-stage that were normally operating or are intended for operation (e.g. typically operating motors that are intended for repair)
Methodology Applied for Variable Load	For variable load motors, continuous metering is required for each motor grouping while the motors' applicable systems are modulated over their normal operating range. An average kW Demand is used for calculating Energy use. Baseline operating hours can be logged for an interval then extrapolated over a year. In post-VSD installation stage, operating hours should be measured.

Measure #5 – Building Envelope BE-E

Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Use of energy modeling software such as RETScreen and EE4 are required. Simulation modeling shall account for actual glazing types, actual building envelop features, shading, building orientation, local weather data Ontario Building code (OBC) should be used as reference in absence of Baseline parameters. Specify manufacturers' data, industry references, for thermal or leakage properties.
Proposed System Description	Use of energy modeling software such as RETScreen and EE4 are required. Simulation modeling shall account for actual glazing types, actual building envelop features, shading, building orientation, local weather data Ontario Building code (OBC) should be used as reference in absence of Baseline parameters. Specify manufacturers' data, industry references, for thermal or leakage properties. Blower door test is required to demonstrate infiltration reduction Simulations should demonstrate solar effects and coincident loading for all orientations
Measurement Boundaries	Measurement boundary should cover all the area impacted by proposed measure
Measurement Conditions	Measurements should be under normal operating conditions.
Sampling	Not Applicable
Baseline Period and Reporting Period	Baseline period should be not less than the most recent 12 months prior to the Retrofit installation period. A minimum of 6 months is required for the monitoring period covering the peak demand period over a block of hours as defined in IESO's EM&V protocol.
Demand Savings Calculation	To be based on hour-by-hour annual whole building model. Refer to EM&V's protocol for demand saving definition
Energy Savings Calculation	Hour-by-hour annual whole building energy simulation model calibrated against whole building metered data for electricity used in the building.
Baseline Adjustments	Baseline Adjustment should be made based on cooling and heating load and operating hours
Methodology Applied for Variable Load	Variable load exist in BAS projects if they are implemented to enhance cooling/heating fans

Measure #6: Building Automation System (BAS) BAS-E Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Inventory of Baseline equipment affected by the BAS, such as: motors, fans, pumps and controls. Baseline information required for each component including manufacturer, model number, quantity, rated capacity, energy-use factors (such as rated voltage, amps, Btu/hr), nominal efficiency, load served, location, any key parameters such as weather data (HDD, CDD) and operating hours, metering data or whole facility utility bills for a minimum of 12-months
Proposed System Description	Retrofit information required for the BAS and its components. Metering data or whole facility utility bills post-BAS installation for a minimum of 12-months. Any key parameters such as weather data (HDD, CDD) and operating hours
Measurement Boundaries	Measurement boundary should include all the components that are impacted by the new BAS – such as lighting system, cooling and heating equipment, fans, etc.
Measurement Conditions	For all BAS projects, measurement conditions should be comparable between Baseline and Retrofit cases. Operating profile, time and duration of measurement and other measured parameters should be obtained and approached in similar methods.
Sampling	As BAS projects are considered as inherently uncertain, all components should be measured and analyzed
Baseline Period and Reporting Period Duration	Reporting duration should reflect full operating profile of all components that are covered under the new BAS. A typical operating profile should reflect the maximum and minimum consumption for the ECM.
Metering Requirements	All **e**nergy-use factors for each components of the existing system should be metered. More complex systems where predicted Savings are greater than 10% of the site's Energy, Utility bill analysis is to be used and metering data is to be obtained from Utility bills using single point meter or a combination of multiple point meters. Measurements can be obtained from Tracking system in Post-stage as well Metering Instructions: For both Baseline and Retrofit: *(1) Energy-use Factors' Measurements* Continuous monitoring of input Energy (e.g. kWh, Btu) or Demand (e.g. kW, Btu/hr) for each component affected by the BAS Upgrade. When seasonal variations or scheduled activity affect equipment operation, metering should be conducted during each variation period Metering period should not include vacations or holidays *(2) Other Key Variables, if applicable:* Cooling loads (Tons), Heating loads (MMBtu)
Demand Savings Calculation	Demand Savings may be available if, for example, the new BAS implements variable speed controls for ventilation fans however, there is high risk of uncertainty. If there is any replacement or modification of existing equipment, it can be applied separately as a different measure. Refer to EM&V's protocol for demand saving definition
Energy Savings Calculation	Energy Savings can be calculated based on using continuous interval measurements. $kWh_{Savings} = (kW_{Baseline} - kW_{Retrofit})_{metered} \times Logged\ Op\ Hrs$
Baseline Adjustments	Baseline Adjustment should be made based on cooling and heating load and operating hours
Methodology Applied for Variable Load	Variable load exist in BAS projects if they are implemented to enhance cooling/heating fans (variable speed/air flow). For various load, continuous interval measurement or kW at various load from engineering reference and/or manufacturer data should be used. Recorded/measured operating profile to be used as basis to find kW at each representative load.

Measure #7: Lighting Controls LC-E Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Inventory of lamp/ballast fixture type affected. Baseline information required for each type including fixture, lamp and ballast types, room conditions, usage area designation, operating periods (e.g. common space 24/7; tenant space lease hours), room location and counts of operating and non-operating fixtures and lamps. Spot-metering data for a Baseline sample that is representative of each usage group
Proposed System Description	Retrofit information required for each lighting type relevant to Project. Operating periods as per post-retrofit lighting controls' settings. Metering data for duration that reflects full operating profile.
Measurement Boundaries	Measurement boundary should include all the lamps that are retrofitted and controlled by the new lighting controls system
Measurement Conditions	Readings for retrofitted fixtures should be taken at least 100 hours of burn-in time following their installation.
Sampling	Baseline fixtures should be grouped into usage groups according to those with similar occupancy areas and/or expected operating hour schedules. At least 6 sample fixtures from each usage group should be subject to metering where measurements are required.
Baseline Period and Reporting Period Duration	Baseline and Reporting Period duration should span through a full operating cycle.
Metering Requirements	Refer to EM&V's protocol for demand saving definition. Metering to be conducted for both Fixture wattages to be measured using spot or short-term representative sample of Baseline and post-installation fixtures (if lamps or ballasts are changed) and Operating hours Metering Instructions: For both Baseline and Retrofit: *(1) Metering of Fixture Wattages:* • Requires the use of RMS meter • Continuous monitoring on a sample population within each usage group should be conducted. The readings will be averaged. • Meters used for this task will need to be calibrated *(2) Logging Operating Hours* • Continuous monitoring on a sample population within each usage group should be conducted for a minimum of one weeks or span of full operating cycle. • When seasonal variations or scheduled activity affect equipment operation, metering should be conducted during each variation period. (E.g. summer operating schedules in classrooms). • Metering period should not include vacations or holidays.
Demand Savings Calculations	Refer to EM&V's protocol for demand saving definition: $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$
Energy Savings Calculation	If Baseline and Retrofit Operating hours are the same: $(1)\ kWh_{Savings} = (kW_{Baseline} - kW_{Retrofit}) \times Stipulated\ Op\ Hrs$ If Baseline and Retrofit Operating hours vary: $(2)\ kWh_{Savings} = (kW \times Op\ Hrs)_{Baseline} - (kW \times Op\ Hrs)_{Retrofit}$ Baseline and Retrofit hours of operation should be logged to establish an operating schedule for each usage group. $Stipulated\ Op\ Hrs = \frac{Fixtures\ ON\ during\ Metering\ Period\ (hrs)}{Length\ of\ Metering\ Period\ (hrs)} \times 8760\ \frac{hrs}{year}$
Baseline	Baseline Adjustments are required in the case that there are non-operating fixtures in the Retrofit

Required Parameters	M&V Guidelines
Adjustments	stage that were normally operating or are intended for operation (e.g. typically operating fixtures that are intended for repair). A de-lamped fixture is not considered a non-operating fixture Lighting levels are to be assessed before applying Baseline adjustments

Measure #8: Tenant Sub-Metering (TSM) TSM-E Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Loads that are proposed to be sub metered. Details of the tenant billing procedure. Description of planned tenant education and engagement activities to support the reduction of discretionary tenant energy usage. Preliminary estimate of metered tenant load, including assumptions.
Proposed System Description	Actual metered tenant electrical load aggregated for the facility in which the TSM project is installed will be determined from measurements of at least one month duration following implementation of a TSM Project. Discount of incremental savings will be from 0-50% depending on the duration of measurement and quality of data and presentation.
Measurement Boundaries	Savings will be determined according to metered tenant load that is subsequently cost allocated as a result of sub-meter installation. Unoccupied floor space shall not be considered.
Measurement Conditions	Savings will be determined according to metered tenant load that is subsequently cost allocated as a result of sub-meter installation. Unoccupied floor space shall not be considered.
Sampling	Statistical qualifiers shall be used to establish Baseline i.e. R^2 >0.75, etc.
Baseline Period and Reporting Period Duration	Actual metered tenant load shall be determined from measurements of at least one month duration following implementation of a TSM Project.
Metering Requirements	Actual metered tenant load shall be determined from measurements of at least one month duration following implementation of a TSM Project.
Demand Savings Calculation	Refer to EM&V's protocol for demand saving definition: $kW_{Savings} = kW_{Baseline} - kW_{Retrofit}$
Energy Savings Calculation	Following an implementation period of not less than 6 months, provide description of tenant engagement experience and supporting metering of tenant usage over the period. A calculation of savings, based on the minimum 6 month engagement period, properly reconciling for vacant space and material changes to energy consuming equipment. Using Option C Whole-facility, the energy savings should be calculated using this equation: $kWh_{Savings} = (kWh_{Baseline} - kWh_{Retrofit}) \pm Routine\ Adjustment \pm Non\ Routine\ Adjustment$

Measure 9: Monitoring and Targeting (M+T) MT-E Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	Provide detailed description of loads or facility areas that are proposed to be monitored. Breakdown of loads connected or facility areas that are proposed to be monitored. Description of the methodology including assumptions used in estimating the target energy and demand savings for the monitoring period. Statistical qualifiers shall be used to establish Baseline i.e. R^2 >0.75, etc. Provide the Estimated Savings Target.
Proposed System Description	Operating logs or other monitoring data to support claimed operating conditions throughout the M&T Monitoring Period is required. Description of the methodology including assumptions used in developing the Estimated Savings Target for the Monitoring Period. List of action items for the education and awareness program. A schematic of the system and the location of the installed meters and confirmation of installation and proper operations. Details on proposed actions items & projects such as costs, timeline, payback, and potential savings. Provide project plan and estimated savings for implementation of identified projects with a payback of less than one year.
Measurement Boundaries	Measurement boundaries should include the entire facility in which the M+T Project is implemented.
Measurement Conditions	Baseline and Retrofit performance is to be measured at the facility level comparing utility metered data e.g. utility bills comparison.
Sampling	Statistical qualifiers shall be used to establish Baseline i.e. R^2 >0.75, etc.
Baseline Period and Reporting Period Duration	M+T Monitoring Period with savings continued for a minimum period of 48 months from the M&T Installation Date. Before calculating the actual Demand Savings and Energy Savings from the M&T Project, the Participant shall monitor and record data from the M&T Project for a period of no less than the M&T Monitoring Period. Energy Savings and Demand Savings in respect of the M&T Project shall only be calculated during the M&T Monitoring Period. Energy Savings achieved from programs under the Initiative Schedule during the M&T Monitoring Period shall be subtracted from the total Energy Savings achieved from the M&T Project. An application shall have a minimum monitoring period of 6 months with annual reporting Report any partial or major equipment or operational changes to Systems within the Monitoring Period. Provide operating logs or other monitoring data to support claimed operating conditions. A calculation of savings, based on the M+T Monitoring Period, properly reconciling for operational changes implemented as well as the education and awareness activities conducted. Demonstrate, following the IPMVP that required savings are achieved and maintained. A minimum of 12 months of utility data shall be collected for pre and post retrofit conditions. Discount of incremental savings will be from 0-50% depending on the duration of measurement and quality of data and presentation.
Metering Requirements	Using utility metered data and sub metered data for monitoring end users energy consumption.
Demand Savings Calculation	Refer to IPMVP Option C Whole-Facility Savings = (Baseline Demand – Reporting Period Demand) ± Routine Adjustments ± Non-Routine Adjustments
Energy Saving Calculation	Refer to IPMVP Option C Whole-Facility Savings = (Baseline Energy – Reporting Period Energy) ± Routine Adjustments ± Non-Routine

Required Parameters	M&V Guidelines
	Adjustments
Baseline Adjustments	Routine adjustments as required, using techniques such as simple comparison or regression analysis. Non-routine adjustments as required.
Additional Information	Estimated Savings Target - In respect of an M+T Project, the savings target estimated to be achieved at the end of the M+T Monitoring Period in kW and kWh. M&T Installation Date - The date that the IESO confirms that (i) the M&T Project is fully functional; (ii) the M&T System has been installed; and (iii) the IESO has received an invoice from the Participant showing proof of payment of the installed equipment in respect of the M&T Project. M&T Monitoring Period - A period of no less than 6 months prior to calculating the actual Demand Savings and Energy Savings from an M&T Project. M&T System - Equipment to monitor the energy and/or demand performance (including electricity performance) of a System relative to the production of such System, for purposes that include setting targets for future energy performance, and assisting with the implementation of savings targets through continuous feedback obtained or received from the M&T System.

Measure 10: Other Custom Measures OCM-E Go Back to Table 1

M&V for Other Custom Measures must adhere to the principles described in the IPMVP Core Concepts, and Statistics and Uncertainty June 2014 or later. M&V should also be consistent with the principles described here as applying to the Industrial Accelerator Program RETROFIT program and consistent with Measure specific M&V procedures as described here, to the extent applicable. Generic 'Enhanced' M&V Plan template can be found in Appendix C.

Measure 11: Power Conditions Devices PCD-E Go Back to Table 1

Required Parameters	M&V Guidelines
Existing System Description	This procedure addresses the application of power conditioning devices that are connected either directly at end-use equipment or at a distribution panel or service entrance serving multiple end use loads and/or circuits.
Proposed System Description	Power conditioning devices are employed to provide operational benefits and cost savings through techniques such as voltage regulation, power factor correction, reduction of harmonic content, and elimination of electrical transients. While tangible operational benefits can result from employing such devices, it must be noted that the Equipment Replacement Incentive Initiative 2015 – 2020 only provides incentives for quantifiable energy reductions and/or peak demand reductions measured as real power (kW) or energy (kWh). To confirm, savings in reactive power (kVar) or apparent power (kVA) are not eligible for incentives. Savings attributable to the application of power conditioning equipment are considered to be specific to the end use equipment and its operating characteristics, and the local electrical environment. An ideal M&V approach is to assess the energy usage of given end-use equipment, both with and without the application of the power conditioning device, under identical operating conditions. In practice, comparing under identical operating conditions may not be practical due to normal variations in equipment loading and electrical supply conditions. Recognizing this inherent variability, the M&V procedure for Power Conditioning Devices is designed to minimize the effects of variability by employing successive measurements with the power conditioning device activated and not activated (i.e. 'On-Off') over a period of time.
Measurement Boundaries	Adhere to the principles described in the IPMVP Core Concepts
Measurement Conditions	Adhere to the principles described in the IPMVP Core Concepts
Sampling	Where multiple Power Conditioning Devices are employed the sample size for measurement shall be 20% of the equipment operating under like conditions.
Baseline Period and Reporting Period Duration	Adhere to the principles described in the IPMVP Core Concepts
Metering Requirements	Specific procedures are as follows: Measurements of real power (kW) shall be taken with a three-phase power analyzer capable of recording at a minimum of 128 samples per cycle, and calibrated to within +/- 1% of reading accuracy. Measurements shall be taken on the load that is subject to the application of the power condition device under typical operating conditions, with a minimum of expected variability.

Required Parameters	M&V Guidelines
	Measurements shall be recorded for successive 15 minute intervals of the power conditioning device being activated and not activated. These recordings shall occur over a period of a minimum of 4 hours duration, over which time there shall be a minimum of 8 fifteen minute periods of the power conditioning device being both activated and not activated.
Demand Savings Calculation	Demand (kW) Savings, if they are to be considered, shall be assessed as the difference in average demand in each of the 'on' and 'off' recorded intervals. Average demand is to be calculated as total cumulative energy in kWh divided by total hours for intervals in which the power conditioning device is activated, and not activated, respectively. Note that for demand savings to be considered the measurements shall be taken on business days during the hours of 1 p.m. to 7 p.m. June 1 through September 30 and the application must be considered to be operating routinely during such times. Refer to the demand savings definition on Page 3.
Energy Saving Calculation	Energy (kWh) Savings for the measurement period shall be assessed as the difference between the cumulative recorded energy in each of the 'on' and 'off' intervals. Annual energy savings shall be considered as the % energy savings during the measurement period multiplied by the annual consumption of the measured circuit/application. Annual consumption can be estimated by extrapolating from recorded energy usage of minimum 1 week duration.
Baseline Adjustments	Adhere to the principles described in the IPMVP Core Concepts

APPENDIX C: Generic M&V Templates

Generic 'Basic' M&V Plan

Go Back to Table 1

1.0 Project General Information
Application Identifier
Building Name: Building Address: Building Type: Application #:
Facility Overview
Provide a brief description of the facility where the retrofit project will take place including approximately square footage, number of floors, type of facility (e.g. office, warehouse, etc) and occupancy schedule. *Note: This will help the reviewer to evaluate the appropriateness of the M&V plan, given the size and complexity of the facility.*
Timelines and Dates
Details of project time lines and milestones and document dates such as: Estimated Start Date: Estimated Completion Date: Actual Start Date: Actual Completion Date: In Service Date:
2.0 Energy Conservation Measures (ECM) Intent
Describe the ECM, its intended result, and the operational verification procedures that will be used to verify the successful implementation of each ECM. Identify any planned changes to conditions of the baseline, such as unoccupied building temperature settings.
3.0 Baseline: Period, energy and conditions
Document the facility's baseline conditions and energy data, within the boundary. This baseline documentation should include: a) baseline energy consumption and demand data; b) independent variable data coinciding with the energy data (e.g., production data, ambient temperature);

c) static factors coinciding with the energy data;
   1) occupancy type, density and periods;
   2) operating conditions for each baseline operating period and season, other than the independent variables;
   3) description of any baseline conditions that fall short of required conditions;
d) details of adjustments that are necessary to the baseline energy data to reflect the energy management program's expected improvement from baseline conditions;

5.0 Basis for Adjustment

Declare the set of conditions to which energy measurements will be adjusted. The conditions may be those of the reporting period or some other set of fixed conditions. The conditions for the basis for adjustment determine whether savings are reported as avoided energy or as normalized savings.

6.0 Analysis Procedure

Specify the exact data analysis procedures, algorithms and assumptions to be used in each savings report. For each mathematical model used, report the terms, and range of independent variables over which it is valid. The energy and demand savings estimates are used to determine the pre-approved incentive amount. For Basic M&V, these estimates are reviewed by a project evaluator and, barring any revisions, used to determine the actual incentive amount.

7.0 Report format

Specify how demand and energy savings will be reported and documented.

Generic 'Enhanced' M&V Plan

Go Back to Table 1

1.0 General
Application Identifier
Building Name: Building Address: Building Type: Application #:
Facility Overview
Provide a brief description of the facility where the retrofit project will take place including approximately square footage, number of floors, type of facility (e.g. office, warehouse, etc) and occupancy schedule. *Note: This will help the reviewer to evaluate the appropriateness of the M&V plan, given the size and complexity of the facility.*
Timelines and Dates
Details of project time lines and milestones and document dates such as: Estimated Start Date: Estimated Completion Date: Actual Start Date: Actual Completion Date: In Service Date:
2.0 Energy Conservation Measures (ECM) Intent
Describe the ECM, its intended result, and the operational verification procedures that will be used to verify the successful implementation of each ECM. Identify any planned changes to conditions of the baseline, such as unoccupied building temperature settings.
3.0 Selected IPMVP Option and Measurement Boundary

Specify which IPMVP option will be used to determine savings. Identify the measurement boundary of the savings determination. The boundary may be as narrow as the flow of energy through a pipe or wire, or as broad as the total energy use of one or many facilities. Describe the nature of any interactive effects beyond the measurement boundary together with their possible effects.

Identify IPMVP Volume I, EVO 10000 – 1:2012 M&V Option that will be used for determining the energy and demand savings including brief justification* for the selection of this M&V Option. (Check one box only)

☐ 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:

**For example, M&V Option A is chosen for this lighting retrofit project because it involves only one energy conservation measures – Lighting Retrofit, which retrofit isolation allows the narrowing of the measurement boundary in order to reduce the effort required to monitor independent variables and static factors, when retrofits affect only a portion of the facility.*

4.0 Baseline: Period, energy and conditions

Document the facility's baseline conditions and energy data, within the measurement boundary. This baseline documentation should include:

e) identification of the baseline period;
f) baseline energy consumption and demand data;
g) independent variable data coinciding with the energy data (e.g., production data, ambient temperature);
h) static factors coinciding with the energy data;
    4) occupancy type, density and periods;
    5) operating conditions for each baseline operating period and season, other than the independent variables;
    6) description of any baseline conditions that fall short of required conditions;
i) details of adjustments that are necessary to the baseline energy data to reflect the energy management program's expected improvement from baseline conditions;
j) size, type and insulation of any relevant building envelope elements such as walls, roofs, doors, windows;
k) equipment inventory;
l) equipment operating practices;
m) any design, install, calibrate, and commission and any special measurement equipment that is needed under the plan;
n) Significant equipment problems or outages during the baseline period.

The baseline documentation typically requires well-documented short term metering activities. The extent of this information is determined by the measurement boundary chosen or the scope of the savings determination. If the whole-facility M&V methods are employed, all facility equipment and conditions should be documented.

5.0 Reporting Period

Identify the reporting period, which may be as short as an instantaneous measurement during commission of an ECM, or as long as the time required to recover the investment cost of the ECM.

6.0 Basis for Adjustment

Declare the set of conditions to which energy measurements will be adjusted. The conditions may be those of the reporting period or some other set of fixed conditions. The conditions for the basis for adjustment determine whether savings are reported as avoided energy or as normalized savings.

7.0 Analysis Procedure

Specify the exact data analysis procedures, algorithms and assumptions to be used in each savings report. For each mathematical model used, report the terms, and range of independent variables over which it is valid.

8.0 Energy Prices

Specify the energy prices that will be used to value the savings, and whether and how savings will be adjusted if energy prices change during the ECM or in the future.

9.0 Meter Specifications

Specify the metering points and period if metering is not continuous. For non-utility meters, specify:

- meter characteristics;
- meter reading and witnessing protocol;
- meter commissioning or calibration procedure;
- routine calibration process;
- Method of dealing with lost data and data transfer.

10.0 Monitoring Responsibilities

Assign responsibilities for reporting and recording during the reporting period:

a) energy data;
b) independent variables;
c) Static factors within the measurement boundary.

Identify those individuals that are responsible for conducting M&V activities and prepared the M&V report (analyses and documentation).

Name:	
Title:	
Company:	
Email Address:	
Phone:	
Address:	

11.0 Expected Accuracy

Evaluate the expected accuracy associated with the measurement, data capture, sampling and data analysis. This assessment should include qualitative and any feasible quantitative measures of the level of uncertainty in the measurements and adjustments to be used in the planned savings report.

12.0 Budget

Define the budget and the resources required for the savings determination, both initial setup costs and ongoing costs throughout the reporting period.

13.0 Report format

Specify how results will be reported and documented.

14.0 Quality Assurance

Specify quality-assurance procedures that will be used for savings reports and any interim steps in preparing reports.