ENERGY PERFORMANCE PROGRAM
SCHEDULE "E" M&V PROCEDURES VERSION 1.4

1. EXECUTIVE SUMMARY

1.1 ELIGIBILITY REQUIREMENTS

Minimum 1,500,000 kWh annual consumption (interval metered), predictable/consistent load profiles, and a clearly-defined Project Boundary.

1.2 PROJECT BOUNDARY

Projects can be individual buildings, groups of buildings, or a subset of a buildings in a bulk-metered complex.

1.3 RAW DATA REQUIREMENTS

Hourly, or sub-hourly, interval data from an Approved Meter is required, starting with at least 12 months of baseline history accompanied by the overlapping 24 months of monthly utility data. Independent variable data must be independently verifiable. Rules governing treatment of outliers/gaps are summarized

1.4 BASELINE MODEL REQUIREMENTS

All Baseline Model calculations must be transparent and reproducible by the Technical Reviewer, who will approve all calculations. Baseline Model inputs/outputs will range from hourly to daily.

The form of the Baseline Model is not dictated, but suggestions are provided. Third party modeling software can be used to derive the models. Statistical specifications are provided, and a post-Baseline Model validation procedure is defined.

Allowable modifications to baseline data to reflect known changes in electricity usage should be clearly explained and defined. Baseline Period should be established to include only time periods for which fixed and variables energy-governing facts are known about the facility

1.5 SAVINGS CALCULATION PROCEDURE

For purposes of the program, Energy Savings will be calculated and evaluated on an annual basis. Savings will be calculated as follows:

Avoided Energy Consumption for Year X (kWh) = Baseline Model Output – Pay-for-Performance Period Actual Use ± Routine Adjustment to the Pay-for-Performance Conditions ± Non-Routine Adjustment to Pay-for-Performance Conditions

For purposes of the program, Average Peak Demand Savings will be calculated and evaluated on an annual basis. Savings will be calculated as follows:

Year X Avoided Demand Consumption or Average Peak Demand Savings (kW) = Baseline Model Output – Pay-for-Performance Period Actual Use ± Routine Adjustment to the Pay-for-Performance Conditions ± Non-Routine Adjustment to Pay-for-Performance Conditions

1.6 BASELINE ADJUSTMENTS IN THE PAY-FOR-PERFORMANCE PERIOD

Guidelines with respect to the eligibility of Baseline Adjustments resulting from changes to building electricity consumption during the Pay-for-Performance Period are provided along with illustrative examples of Baseline Adjustment Events.

Any Non-Routine Events (NREs) & Non-Routine Adjustments (NRAs) should be performed in accordance to the IPMVP Application Guide on Non-Routine Events & Adjustments October 2020 EVO 10400 – 1:2020

2. GUIDING PRINCIPLES

For this program, IPMVP Option C (Whole Facility Analysis Approach) will be used. Consistent with this approach, it is important to recognize that savings cannot be measured - they must be calculated, as it is impossible to measure the absence of something.

The following sections briefly summarize guiding principles used to shape the M&V procedures defined in this document.

TRUST

Success of the program depends on trust. This applies to raw data and to all calculations and model output.

TRANSPARENCY

All aspects of savings calculations must be transparent. A fundamental example: Technical Reviewer must be able to recreate and evaluate Baseline Models in a spreadsheet. Black-box models will not be accepted.

CLARITY

At the program level, eligibility rules must be clearly defined. At the individual application level, the Project Boundary must be clearly defined, with supporting documentation.

FLEXIBILITY

The intent is to define an M&V framework that allows applicants to define their own models and their own Project Boundary within a defined framework.

VALIDATION

Calculated savings must be rational, defensible, and properly representative of actual reductions.

The role of the independent Technical Reviewer will be to review and assess all available information, applying professional judgment as required, to ensure that this objective is met.

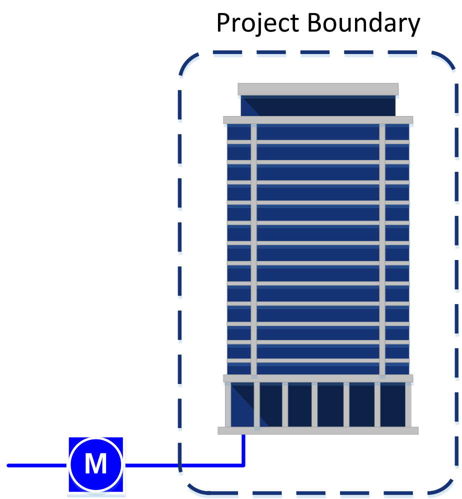
Participants are strongly encouraged to conduct operational verification of implemented measures to ensure measures continue to function as intended such that energy savings are persistent.

3. DEFINING THE PROJECT BOUNDARY

As noted above, IMPVP Option C (Whole Building Analysis Approach) will be used to calculate savings associated with this program. Central to this approach is the understanding that savings are being calculated for a given Project Boundary. For purposes of this program, the following defines possible project boundaries:

3.1 STAND-ALONE BUILDING METERED BY LDC

A stand-alone building, metered and billed for electricity use by a Local Distribution Company (LDC), would have a simple Project Boundary.

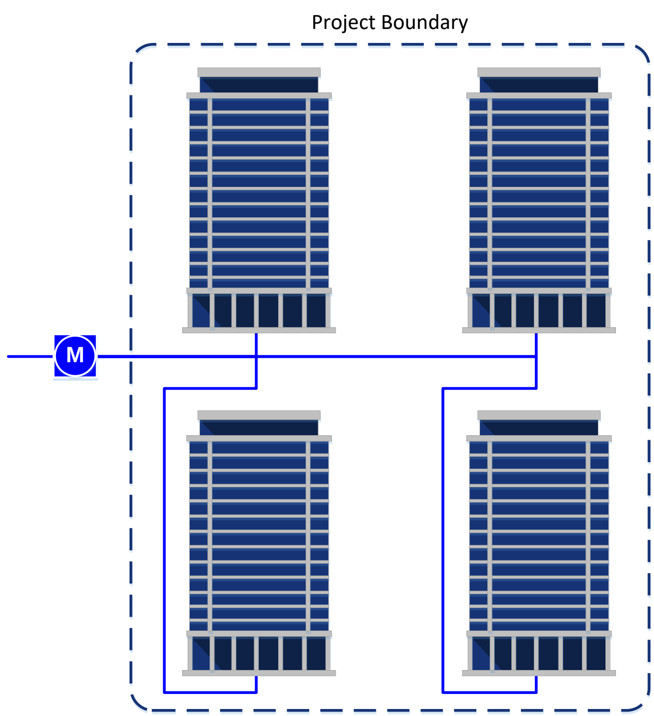


Stipulations:

All General Service accounts > 50 kW associated with the property and billed to the Applicant must be included in the P4P application.

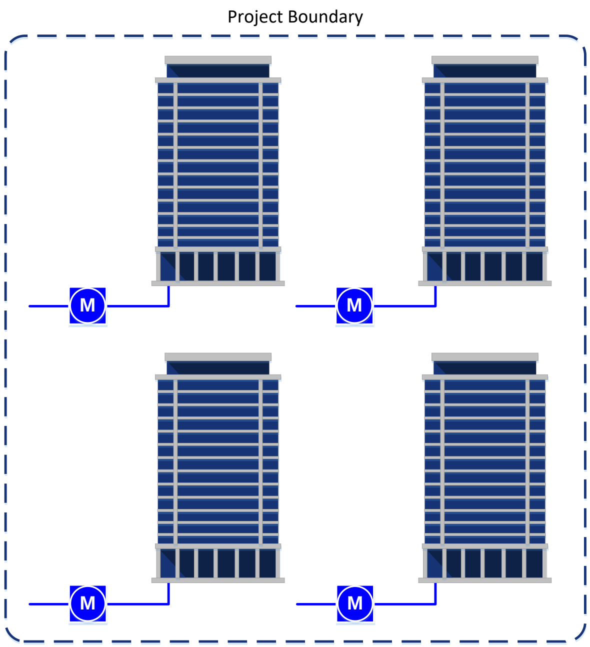
3.2 MULTIPLE BUILDINGS (COMPLEX) METERED IN AGGREGATE BY LDC

Certain properties comprising multiple buildings are bulk-metered by the LDC.



3.3 MULTIPLE SIMILAR BUILDINGS METERED SEPARATELY BY LDC

An applicant may choose to aggregate several smaller buildings that individually do not meet the minimum annual consumption threshold of 1,500,000 kWh.



Stipulations:

(a) Aggregated buildings must be similar by type (e.g. office, grocery retail). The buildings do not have to be the same size, but should have similar load profiles.

(b) A single model using a single weather station, shall be prepared for the aggregate load profile of the buildings included. If NASA is used as the source of the weather data, a single building included in the model will be selected as the weather location.

(c) Aggregated buildings must all be served by General Service 50 - 5000 kW electricity accounts.

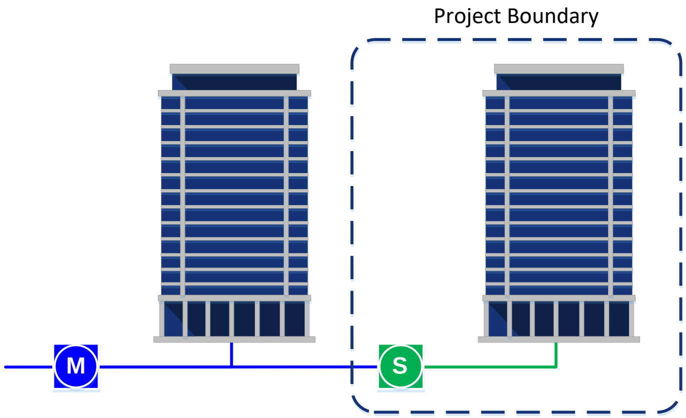
(d) A maximum of five (5) buildings may be aggregated for a single application.

(e) No individual building can exceed the annual consumption threshold of 1,500,000 kWh.

Please note that the aggregated buildings do not need to be served by the same LDC.

3.4 INDIVIDUALLY SUBMETERED BUILDINGS IN COMPLEXES

A large building (minimum annual electricity consumption of 1,500,000 kWh) that forms part of a multi-building complex that is metered and billed in aggregate by the LDC may also participate if its total electricity consumption is submetered.



Stipulations:

(f) Consistent with the *Raw Data Requirements* defined elsewhere in this report, the meter (or meters) used in the submetering system must be Approved Meters.

(g) The Project Boundary must be clearly defined by way of a single line diagram, and, depending on the complexity of the submetering required, an accompanying narrative/report clearly explaining how electricity consumption for the building is measured and calculated.

4. RAW DATA REQUIREMENTS

To calculate savings for this program, actual metered hourly data collected during the Pay-for-Performance Period is compared to the output of a Baseline Model as a function of independent variables (e.g. weather). Baseline Models will be derived based on actual metered hourly electricity data as well as independent variable data collected during the Baseline Period.

This section outlines the requirements pertaining to the raw data streams used in this program.

4.1 ACTUAL METERED HOURLY INTERVAL ELECTRICITY CONSUMPTION DATA IS REQUIRED.

Actual historical hourly interval data must be submitted for both the Baseline and the Pay-for-Performance periods. For certainty, for the calculation of Energy Savings, there is no requirement for the Baseline Model input/output to be hourly – it could be as coarse as daily – but the underlying actual hourly data must be submitted to the IESO.

Savings calculations will be prepared based on the difference between actual consumption during the Pay-for-Performance Period and Baseline Model output for the same period.

4.2 SUBMETER DATA MUST INCLUDE HOURLY DATA AND DAILY READINGS.

For submetered loads, daily readings are required for each submetered point in addition to hourly data.

4.3 A MINIMUM OF 12 MONTHS OF BASELINE PERIOD INTERVAL DATA IS REQUIRED.

A minimum of 12 months of consecutive hourly interval data accompanied by the overlapping 24 months of monthly utility data must be provided. This data will provide evidence that the model based on the most recent 12 months is valid.

4.4 THE BASELINE MODEL WILL BE BASED ON THE MOST RECENT 12 MONTHS OF DATA.

The most recent 12 months of data will be used to reflect the most current operation of the building. Alternate baseline periods may be accepted at the discretion of the Technical Reviewer where the most recent data is not representative of typical building conditions.

4.5 HOURLY INTERVAL DATA FOR THE PAY-FOR-PERFORMANCE PERIOD MUST BE COMPLETE.

It is recognized that some data gaps are inevitable. During the Pay-for-Performance Period, hourly data can be estimated (gaps filled, using a transparent/reasonable approach to be approved by the Technical Reviewer) for a given dataset. Please refer to Appendix D for illustrative examples of gap filling techniques.

It is generally expected that less than 1% of data will need to be gap filled. The Technical Reviewer will have the discretion to de-rate calculated savings if more than 1% of data is estimated.

4.6 METERING MUST BE DONE WITH AN APPROVED METER

All meters used to define the Project Boundary must be Approved Meters.

Approved Meter means one of the following:

a) a meter that meets Measurement Canada requirements for revenue billing, including approval by type, has been tested and sealed by an accredited Measurement Canada meter shop, and has had a Measurement Canada S-E-04 inspection by a firm accredited by Measurement Canada for this work. The Measurement Canada meter requirements can be found here: Measurement Canada Meter Requirements

b) a meter that meets the following requirements:

   i. is a solid-state, true root mean square, electric meter or watt transducer;

   ii. has been calibrated and verified in accordance with the manufacturer's instructions to be accurate within +/- 0.5%;

   iii. and has been approved by the IESO, in its sole and absolute discretion, for use at the Facility and for the specific Eligible Measures being implemented as part of the Energy Performance Program.

The meter approval process is on a case-by-case basis and is pertinent to the specific EPP Application and must be submitted as part of the Application process.

4.7 INDEPENDENT VARIABLE DATA MUST BE INDEPENDENTLY VERIFIABLE.

It is essential that independent variable data be trusted. As such, independent variable data used must fall into one of the following categories:

Weather data: hourly or average daily temperature data from either a local Environment Canada weather station or NASA 's Near Real-time Global Radiation and Meteorology project (as used by Natural Resources Canada's RETScreen tool) should be used. Participants with multiple facilities participating in the Program can use either Environment Canada or NASA's weather data, but cannot use both interchangeably across the participating Facilities.

On-site (non-weather) data: data for other independent variables impacting electricity consumption must consist of *measured* values, automatically and continuously recorded, with the on-site source data available for review by the Technical Reviewer. Examples of on-site data can be, but not limited to, occupancy rate, process loads, or other manufacturing data.

For clarity:

For Energy Savings, data collected must have daily granularity at a minimum. Monthly data will not be accepted. For those who are claiming Average Peak Demand Savings, data collected must have hourly granularity at a minimum (Sub-hourly data should be summed to hourly)

Occupancy (i.e. the number of people in a building on a single day) may be accepted as an independent model variable where meeting the standard criteria for acceptable on-site non-weather data (measured, automatically and continuously recorded, on site source data available for review) as determined by the Technical Reviewer, for example, where daily unique keycard use is automatically counted and logged. Estimates or manual counts of occupancy will not be accepted as an independent variable. Please note that predictable changes in interday occupancy can be typically be accounted for through the use of different day types in modelling (weekday, weekend/holiday, etc.) as illustrated in Appendix C.

Occupancy data for hotels (i.e. rooms rented per day) may be accepted as independent variable data, as whether a room is rented or not can be treated as a quantifiable daily event.

Material step changes in the number of occupants that can be demonstrated to impact electricity consumption *may* be accepted by the IESO as the basis of any proposed modification/adjustment to the Baseline Model (subject to the conditions set out in Section 6.6) and/or for Baseline Adjustments during the Pay-for-Performance Period (see Section 8).

Vacancy data (e.g. for unleased space in rental properties) will not be accepted as an independent model variable, as vacancy is not *measured,* it is not recorded continuously, and available data is not necessarily properly representative of the use of the space given the complexity associated with free rent periods, leased but unoccupied space, etc. Material step changes in vacancy that can be demonstrated to impact electricity consumption *may* be accepted by the IESO as the basis of any proposed modification/adjustment to the Baseline Model (subject to the conditions set out in Section 6.6) and/or for Baseline Adjustments during the Pay-for-Performance Period (see Section 8).

If it is likely that material changes in vacancy or occupancy will impact electricity use at the facility, available data for the Baseline Period should be submitted with the application. Likewise, data for the Pay-for-Performance Period should be submitted with the Savings Report for each year, whether or not a Baseline Adjustment is submitted for the year reported on.

5.0 BASELINE MODEL REQUIREMENTS

As noted above, the Baseline Model will be derived based on actual metered hourly electricity data as well as independent variable data collected during the Baseline Period.

This section outlines the fundamental requirements associated with the Baseline Model.

5.1 THE BASELINE MODEL MUST BE TRANSPARENT.

The Technical Reviewer must be able to recreate and evaluate Baseline Models in a spreadsheet. Black-box models will not be accepted.

For clarity: the method of deriving the Baseline Model need not be transparent. Only the model itself (the 'formula', complete with coefficients) must be made available such that its effectiveness in predicting actual performance can be evaluated.

If an applicant feels their models are proprietary, they will be encouraged to submit models that they are comfortable sharing with the IESO for savings calculation purposes.

Sample Baseline Model calculation methodologies are illustrated in Appendices B and C.

5.2 THE BASELINE MODEL DOCUMENTATION MUST BE COMPLETE.

The Applicant must submit documentation outlining the basis for the model along with statistical information and details of any adjustments to the Baseline Period data, as specified in Section 6 of this report.

5.3 THE BASELINE MODEL MUST MEET MINIMUM SPECIFICATIONS.

The Baseline Model will be screened by the IESO prior to being accepted into the program. The objective will be to confirm that the model output is properly representative of building operation during the Baseline Period.

In addition to the information requirements outlined in Section 6, the Applicant will be required to submit two reports as described in Section 7 with their application to participate in the program.

5.4 THE BASELINE MODEL MUST BE APPROVED BY THE TECHNICAL REVIEWER

Baseline Model calculations must be approved by the Technical Reviewer for acceptance of a Facility in the program. Approval will be contingent upon a clear understanding of the Baseline Model in addition to the model output meeting specific accuracy specifications.

5.5 BASELINE MODEL INPUT/OUTPUT GRANULARITY REQUIREMENTS

Acceptable Baseline Model output granularity ranges from hourly (most granular) to daily (least granular). Monthly data (12 points per year) is not acceptable.

Variations by day type, on/off-peak, etc. are acceptable.

5.6 FORM OF BASELINE MODEL

The program will not dictate the form of the Baseline Models as long as they are transparent, can be reproduced, and are approved by the Technical Reviewer.

In general, it is expected that the model will be of the form:

$y = a_0 + a_1x_1 + a_nx_n$

where y is the dependent variable, x is the independent variable and a0, a1 an are coefficients describing the relationship between the dependent and independent variable(s). (Higher-order regression models are acceptable provided they meet the statistical requirements laid out in Section 6.5.)

Applicants may use as many independent variables that they judge necessary to properly represent baseline electricity consumption over the Pay-for-Performance Period. Models may incorporate categorical time periods such as 'day type' or 'occupied/unoccupied' as independent variables where Applicants see fit.

It is anticipated that weather (heating/cooling degree days/hours) will be the most commonly-used independent variable. As noted above, all data must be independently verifiable. Weather data used for modeling shall be traceable to Environment Canada or NASA. Weather data from other sources such as building automation systems will not be accepted.

5.7 USE OF MULTIPLE REGRESSIONS IN A MODEL

A model can be made up of two or more regressions over the baseline period where it makes sense to do so. In this case, the applicant is to clearly identify the ranges over which the regressions apply. For example, an Applicant may wish to separate the analysis between weekends and weekdays. In this case a model could be made up of the two regressions:

$y_{weekday} = a_{0,weekday} + a_{1,weekday}x_1$

$y_{weekend} = b_{0,weekday} + b_{1,weekday}x_2$

where the regressions would be evaluated over weekday hours and weekend hours accordingly.

This could also be expressed as a single multivariate equation:

$y_{weekday} = a_{0,weekday} + a_{1,weekday}x_1 + b_{0,weekday} + b_{1,weekday}x_2$

Application submission requirements are summarized in Appendix A. Sample Baseline Model calculation methodologies are illustrated in Appendices B and C.

5.8 USE OF 3RD PARTY MODELING SOFTWARE

Third party modeling software can be used to derive the models provided the resulting model calculations, complete with coefficients, are transparent and are provided to the Technical Reviewer meeting all the requirements outlined in these M&V procedures.

6. BASELINE MODEL SUBMISSION REQUIREMENTS

The Applicant must submit documentation outlining the basis for the model along with statistical information and details of any adjustments to the Baseline Period data. These are described in the following sections and are summarized in Appendix A – Checklist: Submission Requirements.

6.1 NARRATIVE DESCRIBING THE MODEL

A narrative providing a description of the basis of the model is required.

6.2 DOCUMENTED CONDITIONS DURING THE BASELINE PERIOD

Existing conditions at the property should be documented before the start of the Pay-for-Performance Period. A detailed and documented understanding of baseline conditions will provide a sound basis for Baseline Adjustments which may be required to account for material and unforeseen changes in electricity use at the building.

Examples of documentation that would be helpful in defining Baseline Period conditions include:

(h) Floor plan showing floor areas by space type

(i) Electrical single line diagrams showing submeter locations as applicable

(j) Heating fuel (electricity, natural gas, other)

(k) Other fuel sources serving the building

(l) Tenant listing (including any vacant spaces), if applicable and available

(m) Occupancy data (i.e. number of occupants), if applicable and available

(n) Building Automation System (BAS) logs documenting operating hours.

(o) Manufacturing production data

6.3 SPREADSHEET WITH MODEL CALCULATIONS

A spreadsheet showing the calculations in terms of how the model output is calculated as a function of the independent variables and the time periods is required.

6.4 BASELINE MODEL STATISTICS

The following statistical indices shall be provided in the submission for review by the Technical Reviewer for each regression (sub-model) used in the overall model:

REQUIREMENT	REPRESENTATIVE FORMULA	DESCRIPTION/PURPOSE
Number of points	n	This is the total number of points used in the regression. Indicates the weight of the regression in the overall model.
Number of parameters	p	Number of coefficients in the regression. For a simple regression y = mx + b, p=2.
Coefficient of Determination (R^2)	$1 - \frac{\sum_i (y_{act} - y_{calc})^2}{\sum_i (y_{act} - y_{avg})^2}$ or $\frac{\sum_i (y_{calc} - y_{cavg})^2}{\sum_i (y_{act} - y_{avg})^2}$	Illustrates how well the independent variables explain the variation in the dependent variable. R^2 values range from 0 (no variation of the dependant variable is associated with the independent variables) to 1 (all variation of the dependent variable is associated with changes in the independent variable). As good engineering practise, an R2 value of 0.75 or higher indicates good correlation. However, a high R^2 in itself is not sufficient to determine whether a model is 'good'. A low R^2 does not indicate a poor model; professional judgment should be applied
Coefficient of Variation of Root Mean Squared Error (CV(RMSE))	$\frac{\sqrt{\frac{\sum_i (y_{act} - y_{calc})^2}{(n-p)}}}{y_{avg}}$	This is the standard deviation of errors of prediction about the regression line normalized by the average y value. It is not affected by the degree of dependence between the independent and dependent variables (e.g. R^2). CV(RMSE) should be less than 15%

Net Determination Bias Error (NDBE)	$\frac{\sum_i (y_{act} - y_{calc})}{\sum_i y_{act}}$	This is the sum of the errors divided by the actual. The NDBE should be less than 0.005% (absolute).
T-Statistic (T_{stat}):	Refer to textbooks on standard statistical procedures.	The coefficient a_n divided by its standard error. T_{stat} to be calculated for each coefficient $a_1,\ldots,a_n$. T_{stat} should be >2 for all coefficients.

This table assumes a basic understanding of statistical methods; applicants are invited to consult published literature on statistical methods for further information.

The Technical Reviewer must be able to reproduce the statistics pertaining to the model.

6.5 TREATMENT OF OUTLIERS IN BASELINE PERIOD RAW DATA

Adjustments to the data in the Baseline Period used for preparation of the model will be accepted under certain conditions to create a more accurate/robust model. Allowable adjustments are outlined as follows:

(p) Gaps/missing data

Missing data shall be omitted for purposes of calculating the Baseline Model. Refer to Appendix D for Illustrative Examples of acceptable Gap Gilling Techniques for gaps/missing data.

In the case where an hourly interval meter is non-functional for an extended period of time, it is the responsibility of the Participant or its representative to obtain utility interval metered data from the Local Distribution Company (LDC) to fill in the missing data gap.

In the absence of hourly interval meter data, where only monthly metered data is available, it is the responsibility of the Participant to determine the differential between the two meters and reconcile the difference between the monthly and hourly metered data. The Participant or its representative will then apply this differential to the next pay-for-performance period ensuring that the Participant and IESO is reconciled for any over or under payment as a result of this missing data during the first reporting period.

(q) Contractual Demand Response Calls

Hours where the site has been required to reduce load due to contractual obligations (e.g. Demand Response program) should be removed from the Baseline Model calculation.

Other Known Outliers

Other outliers may be removed from the raw data for the Baseline Period, subject to approval by the Technical Reviewer. Examples of allowable outliers:

The temporary use of load banks for generator testing

Periods of power failure or generator operation.

All data removed from the dataset shall be documented and submitted with the Baseline Model including the nature/reason for the removal and the period of time affected.

6.6 MODIFICATIONS TO THE BASELINE MODEL REFLECTING CHANGES IN THE BASELINE PERIOD

The purpose of modifying the Baseline Model during the Baseline Period is to arrive at a model that projects properly representative consumption at 'Day 1' of the Pay-for-Performance Period.

All known changes in electricity use that affected electricity consumption in the baseline period should be incorporated into the model, including any activities or measures commissioned which were promoted or funded through a different program or initiative undertaken by any level of Government or utility designed to incentivize electricity savings, except for the Energy Manager Program offered by Save On Energy.

Any projects receiving such electricity saving incentives will trigger a Baseline Adjustment at the discretion of the IESO.

Examples of permissible modifications to the baseline include:

Material energy conservation measures (e.g. lighting retrofit)

Removal/addition of submetered exceptional loads (e.g. data centre loads)

Building expansion/contraction

Major renovation

Traceable/documented operational adjustments

An illustrative example of an acceptable Baseline Adjustment reflecting changes to the building in a Pay-for-Performance Period can be found in Section 8.2.

Modifications should be applied directly to the raw data over the periods they apply to within the Baseline Period. As part of this procedure, a new, second dataset should be created and submitted as the basis for derivation of the Baseline Model.

Guidelines:

Typically, a Baseline Adjustment will represent a known change in electricity consumption starting on a specific date or covering a specific period.

It is recommended that a Baseline Adjustment be expressed in terms of an hourly or daily profile, depending on how data is aggregated for purposes of deriving the Baseline Model. (For purposes of this section, raw hourly data that is grouped into daily data is still considered to be raw data.)

Baseline Adjustments may be positive or negative.

Multiple Baseline Adjustments may be applied. Each will be subject to the approval of the Technical Reviewer.

For a permanent change in consumption (positive or negative), the Baseline Adjustment shall be applied to the raw data during the period from the first day of the baseline period to the date this change in electricity is observed/known.

Similarly, for a temporary change in consumption (positive or negative), the Baseline Adjustment shall be applied to the period when the temporary change occurred.

Applicants can 'smooth' the impact of the Baseline Adjustment to better approximate the transition if the change in electricity use takes a relatively long time to develop. For example, a lighting retrofit may take a month to be implemented, and it is reasonable to assume that over the installation period, the savings will only be partial.

6.7 PROJECTS MAY BE PHYSICALLY INSPECTED TO CONFIRM BASELINE CONDITIONS.

As the materiality of potential incentives is significant, a site visit may be conducted by the IESO or Technical Reviewer to confirm baseline conditions.

7. CALCULATION OF SAVINGS

Savings cannot be measured - they must be calculated, as it is impossible to measure the absence of something.

For this program, it is a given that IMPVP Option C (Whole Building Analysis Approach) will be used.

7.1 ENERGY SAVINGS CALCULATION PROCEDURE

The Baseline Model for a given project, once reviewed and approved by the Technical Reviewer, will not change for the balance of the program unless a Baseline Adjustment is approved in writing by the Technical Reviewer.

For the purpose of the program, Avoided Energy Consumption or savings will be calculated and evaluated on an annual basis. Savings will be calculated as follows:

Year X Avoided Energy Consumption or Energy Savings (kWh) = Baseline Model Output – Pay-for-Performance Period Actual Use ± Routine Adjustment to the Pay-for-Performance Conditions ± Non-Routine Adjustment to Pay-for-Performance Conditions

Baseline Adjustments represent eligible and verified changes to the building during the Pay-for-Performance Period that impact electricity use. Procedures governing Baseline Adjustments are outlined in Section 8.0.

Savings are to be reported by Participants using the Savings Report Template available at https://www.saveonenergy.ca/For-Business-and-Industry/Programs-and-incentives/Energy-Performance-Program.

Negative savings will not be zeroed out. For each Pay-for-Performance Period, negative savings will offset positive savings.

7.2 BASELINE ADJUSTMENT PROCEDURE

A Baseline Adjustment request will consist of:

A description of the Baseline Adjustment Event

The change in kWh (positive or negative) due to this change, summarized monthly.

Supporting calculations and/or submeter data, organized and explained in a manner such that they are understandable and can be validated by the Technical Reviewer .

A Baseline Adjustment Request template can be found in Appendix G.

The Technical Reviewer will review the calculations and will work with the Applicant to confirm that each requested Baseline Adjustment is material and properly representative of the impact of actual changes to the building or building operations. The Technical Reviewer must approve the final Baseline Adjustment value.

For clarity:

A separate Baseline Adjustment Request is required for each type of Baseline Adjustment Event. (Separate but similar events may be grouped together provided the calculation methodology is consistent.)

7.3 AVERAGE PEAK DEMAND SAVINGS CALCULATION PROCEDURE

This section describes the M&V Procedures for claiming Average Peak Demand Savings. Average Peak Demand Savings is defined as the average load reduction in electricity demand between the Baseline Period and the Pay-for-Performance Period occurring between 1:00pm – 7:00pm Eastern Daylight Time (EDT) or 12:00pm – 6:00pm Eastern Standard Time (EST) during all days from June 1 through August 31, inclusive, that are not a weekend or Federal/Provincial holiday. For the purpose of the Energy Performance Program, the verified Average Peak Demand Savings will be expressed in kilowatts (kW). Refer to 'EM&V Protocols and Requirements V3.0' for more details on Standard Definition of peak for calculating Average Peak demand Savings at IESO Evaluation Measurement and Verification Version 3.0 (Page 75 - 79)

For the purpose of the Energy Performance Program, Average Peak Demand Savings will be calculated and evaluated on an annual basis and calculated as follows:

Year X Avoided Demand Consumption or Average Peak Demand Savings (kW) = Baseline Model Output – Pay-for-Performance Period Actual Use ± Routine Adjustment to the Pay-for-Performance Conditions ± Non-Routine Adjustment to Pay-for-Performance Conditions.

For greater certainty, a Baseline Model output using hourly electrical demand data is required to determine Peak Demand Savings. Baseline Model outputs using daily electrical energy consumption can be used to determine Energy Savings only but not Peak Demand Savings. The Baseline Model output using hourly electrical demand data can be used for both Energy Savings and Peak Demand Savings.

8. BASELINE ADJUSTMENTS IN THE PAY-FOR-PERFORMANCE PERIOD

The purpose of this section is to illustrate, with examples, the kinds of changes to the building during the Pay-for-Performance Period require a Baseline Adjustment, along with a description of the Baseline Adjustment procedure.

A Baseline Adjustment would be calculated and applied to the savings calculated using the Baseline Model such that calculated savings remain properly representative of actual in the face of material changes to building operation/use.

In all cases, the Technical Reviewer will review the Baseline Adjustment to ensure that they are properly representative of actual. If necessary, the Technical Reviewer will conduct an on-site investigation to confirm changes.

Please note that where ambiguity exists, Participants may consult with the Technical Reviewer to confirm if a Baseline Adjustment is necessary.

Please refer to Appendix H for a Sample Baseline Adjustment Request template.

8.1 KEY CHARACTERISTICS OF BASELINE ADJUSTMENT EVENTS

Any NREs & NRAs should be performed in adherence to the IPMVP Application Guide on Non-Routine Events & Adjustments, October 2020, EVO 10400 – 1:2020 The key characteristics of a Baseline Adjustment Event are as follows:

The change in electricity use is material enough to be apparent upon review of the hourly electricity consumption profile. As a general rule, the adjustment should represent at least 10% of the minimum 5% savings threshold for the program (i.e. 0.5% of baseline consumption).

The change in electricity use is quantifiable using either submeter data or standard engineering calculations.

The details of the change in electricity use can independently be verified.

Unless determined otherwise by the IESO or Technical Reviewer, the following events constitute a Baseline Adjustment Event:

- Part or whole of the facility is repurposed for a different business function
- The building is expanded
- Fuel-switching
- The installation of a behind-the-meter generation project

Examples of Baseline NREs and NRAs:

Eligible baseline events will generally fall into the following categories:

Repurposed space: a portion of the building is modified such that it can be used for a different business purpose.

Unmetered example: a section of a retail store is converted from storage (low lighting levels) to retail (high lighting levels). Neither the new nor the old lighting is submetered, so the Baseline Adjustment is prepared based on engineering calculations.

Submetered example: typical office space is converted to a data centre. As the data centre is expected to consume much more electricity than typical office space, it is submetered. In this case the Baseline Adjustment is calculated based on the difference between the submetered data centre use (typically a flat load) and a reasonable estimate of typical office use.

Addition to the building: a new section is added to the building.

Unmetered example: a new wing is added to an enclosed mall but is not submetered. In this case it may not be practical to calculate a properly representative Baseline Adjustment.

Submetered example: a new wing is added to an enclosed mall and is submetered. In this case the Baseline Adjustment is calculated based on actual submetered use associated with the new wing.

Material change in building operation: a law firm has 3 months of after-hour HVAC requests as they deal with a major case, leading to a material and quantifiable increase in electricity use during the Pay-for-Performance Period.

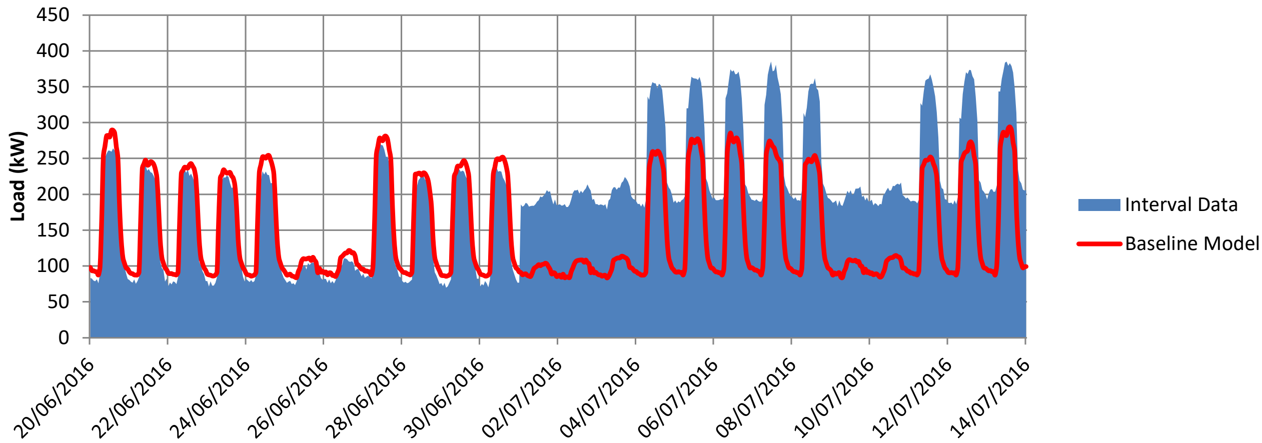
An engineering calculation of increased electricity use would be prepared as a Baseline Adjustment for review by the Technical Reviewer. Once the Applicant and the Technical Reviewer come to agreement on a properly representative calculation of additional electricity use associated with after-hours HVAC requests, this would be applied to the Baseline Model.

Material step changes in occupancy (daily number of occupants) or vacancy (unleased space in a rental property) that can be demonstrated to impact electricity consumption *may* be accepted by the IESO as Baseline Adjustments during the Pay-for-Performance Period

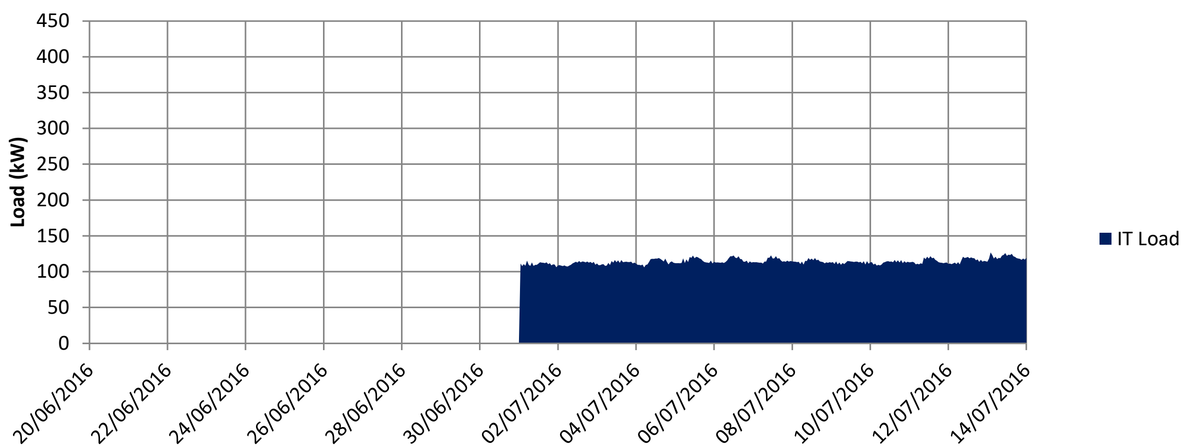
COVID-19 Interruption: When business is impacted and interrupted by COVID-19 situation, it is considered a NRE and a NRA should be performed in accordance to the IPMVP Application Guide on Non-Routine Events & Adjustments October 2020 EVO 10400 – 1:2020. For clarity, for all EPP contracts, hourly interval data, whether it is utility metered or sub-metered, collected during the period of suspension of normal business operation, is deemed invalid interval data for any reporting period. Such period interval data should not be used in determining annual energy savings. The reason is that the energy consumption during this period is reduced because of facility shutdown and/or an interim work-from-home policy for social distancing, and not because of energy efficiency activities undertaken by the participant. Energy savings will be artificially inflated when comparing the energy consumption to the baseline for this period and these savings cannot be sustained.

8.2 ILLUSTRATIVE EXAMPLE: DATA CENTRE INSTALLED IN OFFICE BUILDING

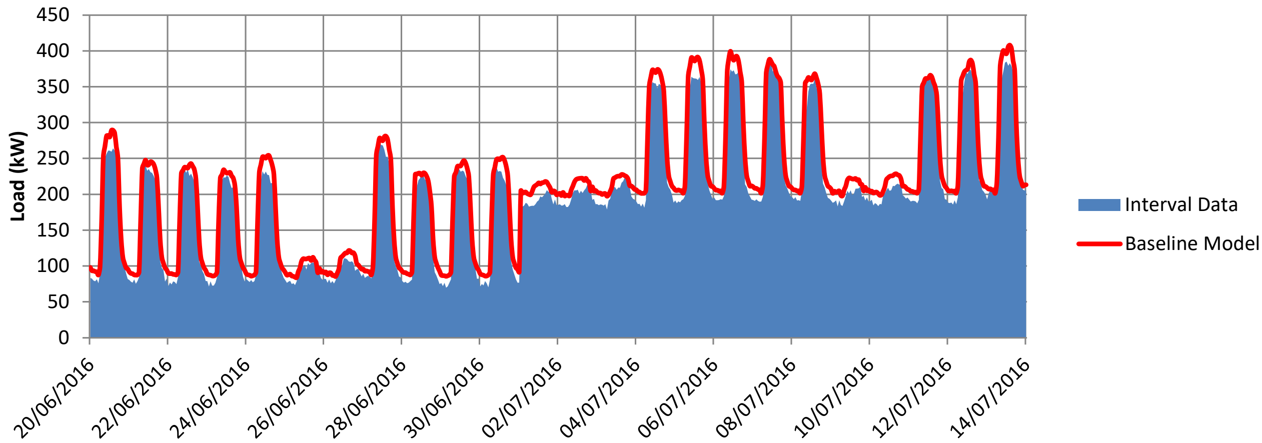
A commercial office building is demonstrating performance gains through operational improvements. On July 1 a tenant activates a newly-installed data centre. The resulting hourly profile for the building is illustrated in the following chart:



Review of the interval data confirms that this load materially impacts the electricity consumption profile of the building. The data centre load, captured by a Measurement Canada certified submeter, has the following load profile:



A Baseline Adjustment consisting of actual submetered use associated with the data centre is applied by adding it to the Baseline Model output effective July 1. This is illustrated in the following chart.


Load (kW)
450
400
350
300
250
200
150
100
50
0
20/06/2016
22/06/2016
24/06/2016
26/06/2016
28/06/2016
30/06/2016
02/07/2016
04/07/2016
06/07/2016
08/07/2016
10/07/2016
12/07/2016
14/07/2016
Interval Data
Baseline Model

APPENDIX A - ENERGY BASELINE MODEL SUBMISSION REQUIREMENTS

The following information shall be an integral part of the Energy Performance Program Agreement:

General:

Facility Boundary with supporting documentation

Facility description: address(es), building type, age of building(s), size of building(s) (sqft), heating fuel (electricity, natural gas, other), other fuel sources to the building(s).

LDC electricity account number(s) and historical data including a recent sample LDC bill.

Raw Data

Datasets (.csv format)

Raw hourly electricity interval data for all meters

Raw daily electrical readings for all submeters (if applicable)

Independent Variable Data:

Weather station used (if applicable)

Raw daily or hourly weather data (as applicable)

Raw data for other independent variables (if applicable)

Baseline Model Details:

Narrative describing the model and the parameters used (as per Section 6.1)

Start date and end date of the baseline modeling period

Spreadsheet with Baseline Model calculations (as per Section 6.3)

Descriptive statistics for each regression model (as per Section 6.4)

Details of treatment of all outliers and omissions from the data set (as per Section 6.5)

Details of all modifications to the Baseline Model reflecting changes during the baseline period (as per Section 6.6)

Model output (minimum granularity: daily) reflecting any modifications to the data for the Baseline Period (where applicable).

APPENDIX B - SAMPLE (SIMPLE) BASELINE MODEL DESCRIPTION

Savings calculations will adhere to IPMVP protocols, specifically Option C – Whole Facility Analysis using hourly interval data.

The key to this program will be the establishment of a robust and facility-specific weather-normalized Baseline Model of daily electricity use that can be compared to actual performance.

Period Types:

Weekdays: all hours, Monday to Friday

Weekends/Holidays: all hours, Saturday/Sunday/holidays

Calculation of Facility-Specific Weather Adjusted Baseline Model:

The facility in question has a consistent load profile from day to day during the winter months, with increased use as a function of cooling degree hours in summer.

It is proposed that daily electricity use, separated by period type as described above, be modeled as a function of cooling degree hours using linear regression. For clarity, there would be two regression models: weekdays and weekends/holidays.

Cooling degree hours are a function of the balance temperature (the temperature at which the store needs neither heating nor cooling). The balance temperature is a property of the building, and is derived by finding the best fit of the regression model. For clarity, actual weather data for the Baseline Period should be used in the regression analysis.

Each regression model would be of the form $y = mx + b$, where

y = the modeled use for the period (24 hours), in kWh

m = kWh consumption per cooling degree hour (CDH)

b = baseload electricity use for the period, in kWh

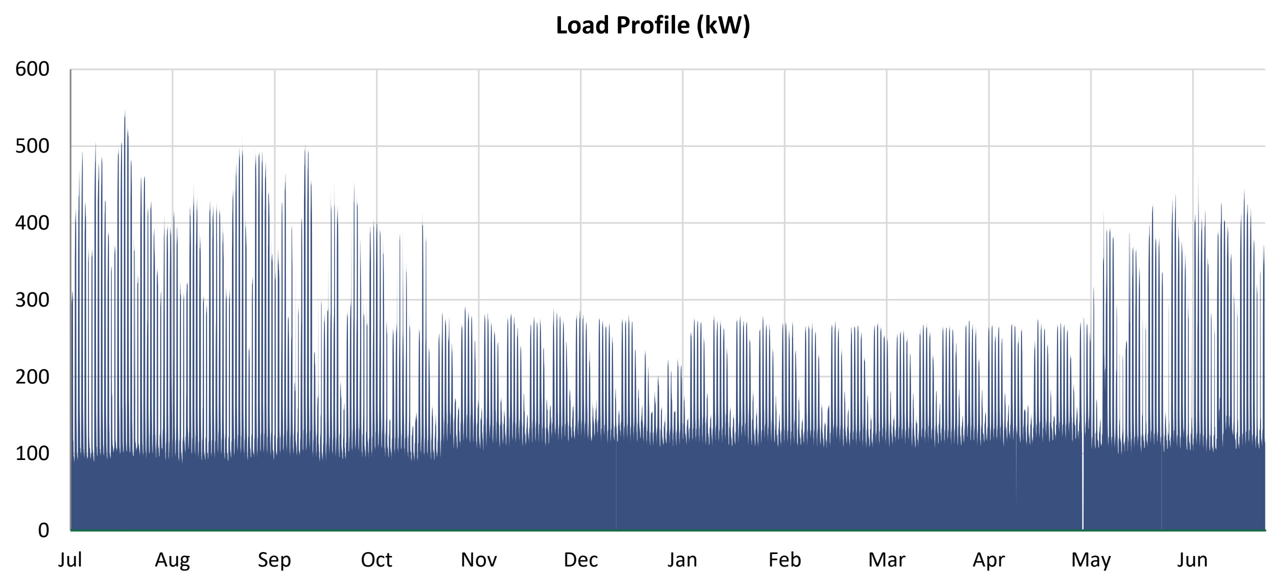
Actual use, divided into the appropriate period types as specified above, would be compared to modeled baseline use to calculate savings.

APPENDIX C - ILLUSTRATIVE EXAMPLE: SAMPLE BASELINE MODELING PROCESS

The purpose of this Appendix is to walk the reader through a recommended approach to preparing a Baseline Model for a sample office building, including the intended use of the statistical indices and reports specified in this document.

<u>Preparation of the Model</u>

The sample office building's load profile (July 2015 to June 2016) is shown in the following chart.



Based on discussions with property management, the building is primarily occupied Monday to Friday from 9:00 AM to 5:00 PM, and occupancy is fairly constant throughout the week. Some tenants work on Saturdays and fewer work on Sundays. During statutory holidays the building is officially closed, but tenants sometimes come to work on these days. Property management indicated there have been no major renovations over the past 4 years.

Based on this information, it was decided that the hourly interval data would be converted to daily consumption data, and that a model would be developed as a function of average daily temperatures for 4 different day types:

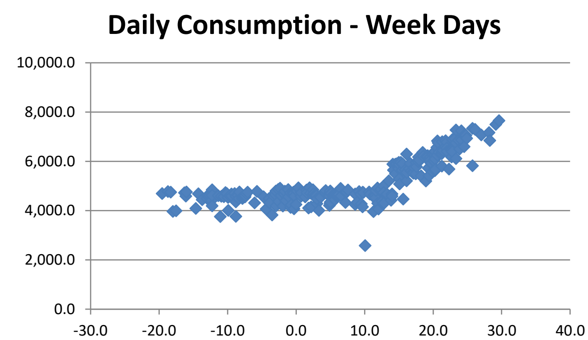
Weekdays (Monday to Friday)

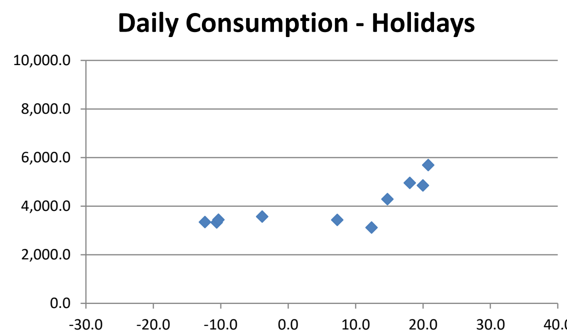
Saturdays

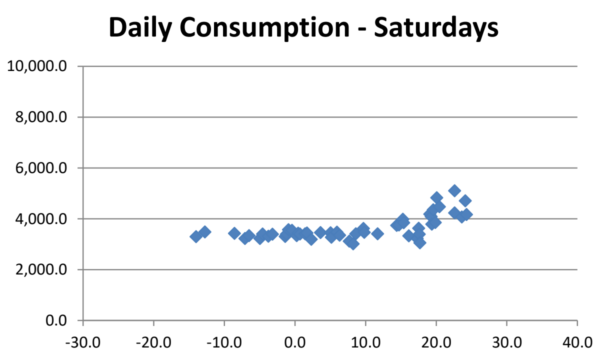
Sundays

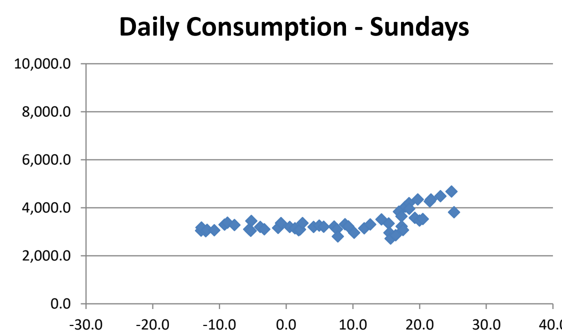
Holidays

The daily consumption was plotted as a function of temperature to see if there was any correlation with daily average temperatures. The results are shown in the following charts.









From the charts it is clear there is a positive correlation with average daily temperature above a certain ‘balance’ temperature, for all 4 day types.

With this information it was decided to calculate linear regression models (ie y = mx + b, where ‘m’ and the ‘b’ are the parameters) for the electricity data as a function of cooling degree days (CDD, effectively describing how hot it was on a daily basis). Cooling degree hours are a function of the balance temperature (the temperature at which the store needs neither heating nor cooling). The balance temperature is a property of the building, and was derived by finding the best fit of the regression model.

The following table summarizes the parameters calculated for each of the four models of daily electricity consumption as a function of cooling degree days.

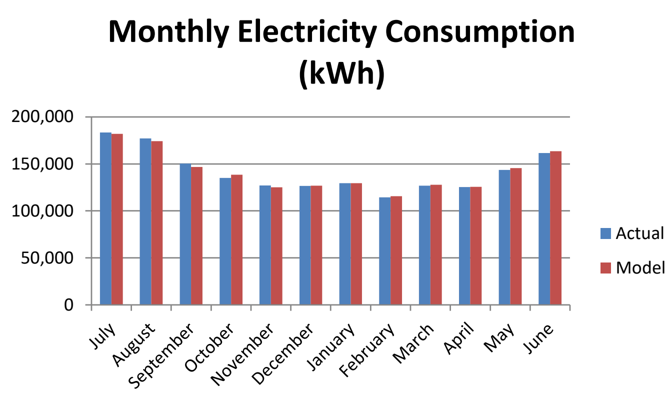
Model Description	Days	Balance Point Temparature (C)	Slope (kWh/CDD)	Intercept (kWh)
Weekdays	251	12.3	243.6	3396.5
Saturday	52	11.1	173.6	4547.5
Sunday	52	10.6	78.4	3350.7
Holiday	10	9	64.5	3119.4

The statistics pertaining to the four models are summarized in the following table:

Model Description	R^2	CV (RMSE)	NDBE	tstat (slope)	tstat (intercept)
Weekdays	0.933	6.1%	0%	10.6	35.8
Saturday	0.853	6.8%	0%	38.0	165.1
Sunday	0.620	7.9%	0%	9.0	67.4
Holiday	0.546	9.1%	0%	7.8	56.9

Model Output

Actual and modeled electricity consumption are plotted by month in the following chart, demonstrating good agreement throughout the baseline period:



Modifications to the Baseline Model

Based on our analysis, and consistent with our discussions with property management, there were no modifications required for the Baseline Model.

APPENDIX D - ILLUSTRATIVE EXAMPLES OF ACCEPTABLE GAP FILLING TECHNIQUES

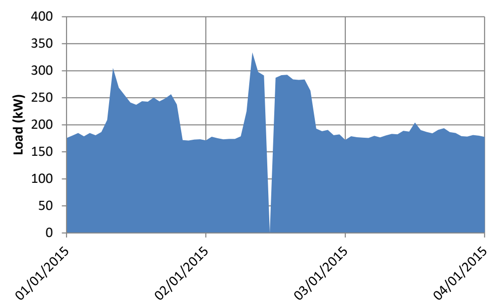
The following examples illustrate acceptable methods to fill gaps.

The technique(s) employed for gap filling are up to the Applicant. The Technical Reviewer will assess validity of each gap filled.

Example 1: Single Point Gap Fill using Interpolation:

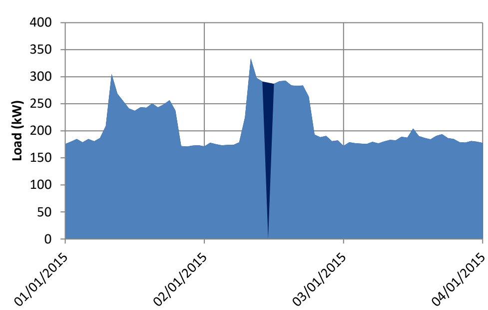
This technique is applicable to most situations where the gap corresponds to a single hour (data point).

In this example a gap in the interval data occurs January 2, 2015 at 11:00AM lasting 1 hour.



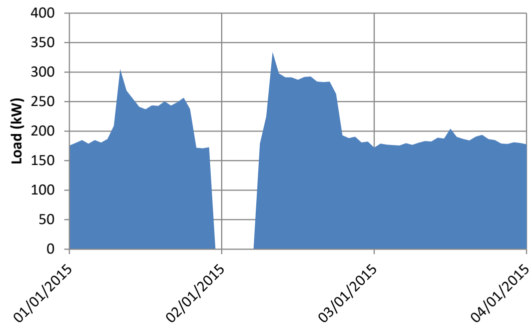
The load just prior to the gap (10:00 AM) was 291 kW and the load just after the gap (12:00 PM) was 287 kW.

The gap was filled with a value of 289 kW, determined by taking the average between the two known data points.



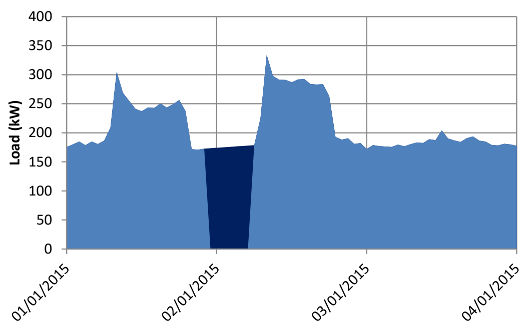
Example 2: Multiple Point Gap Fill over a period of relatively Constant Load using linear interpolation:

In this example a gap in the data occurs between January 2, 2015 11:00PM and January 2, 2015 5:00AM.



An analysis over similar hours on other days was made, and it indicated that the load over which the gap appears is generally constant. The load just prior to the gap (January 1 10:00PM) was 172.7 kW and just after the gap (January 2, 6:00AM) was 178.5 kW.

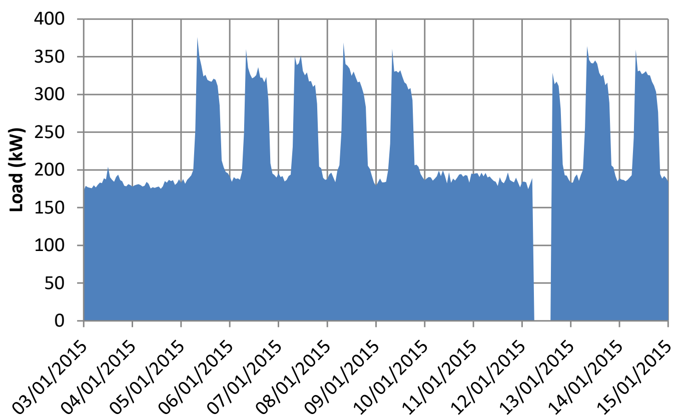
The gap was filled by linear interpolation with the values summarized in the chart.



Timestamp	Load (kW)
Jan-01, 2015 - 10:00 PM	172.7
Jan-01, 2015 - 11:00 PM	172.8
Jan-02, 2015 - 12:00 AM	172.9
Jan-02, 2015 - 1:00 AM	173
Jan-02, 2015 - 2:00 AM	173.1
Jan-02, 2015 - 3:00 AM	173.2
Jan-02, 2015 - 4:00 AM	173.3
Jan-02, 2015 - 5:00 AM	173.4
Jan-02, 2015 - 6:00 AM	173.5

Example 3: Multiple Point Gap Fill using Averaging:

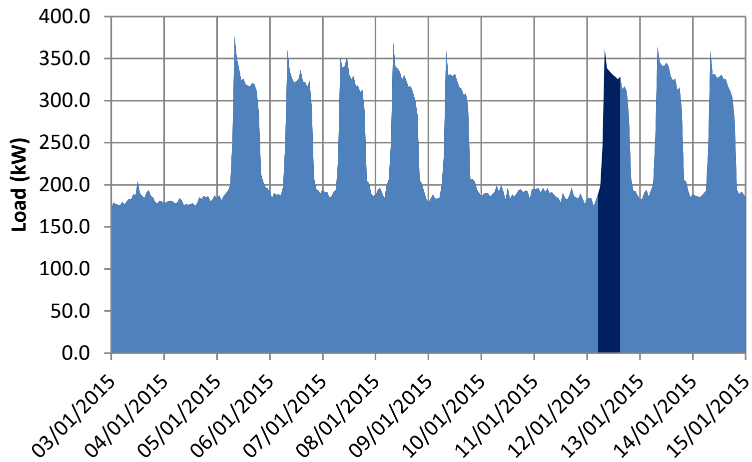
There is a gap in the data January 12, 2015 occurring between 6:00AM and 2:00PM.



An analysis on other days over similar hours that the load over which the gap appears is not constant, but is repeatable.

The gap was filled by averaging interval data over similar time periods representative of the gap.

hour	Date							
beginning	Jan-05	Jan-06	Jan-07	Jan-08	Jan-09	Jan-13	Jan-14	average
6:00AM	199.8	197.4	193.6	206.3	199.5	200.1	192.9	198.5
7:00AM	252.6	249.6	230.6	251.1	234.8	256.4	242.4	245.3
8:00AM	376.0	360.0	350.4	368.8	360.5	364.1	359.4	362.7
9:00AM	349.9	335.4	338.8	340.2	330.2	345.8	330.6	338.7
10:00AM	338.1	326.7	341.3	337.9	331.1	341.6	331.65	335.5
11:00AM	323.8	321.3	351.8	334.2	328.8	341.1	326.85	332.6
12:00PM	326.0	322.8	331.1	324.6	331.9	345.0	328.2	329.9
1:00PM	319.2	325.5	325.3	330.3	323.6	340.6	330.75	327.9
2:00PM	317.7	336.2	329.1	322.9	316.1	328.5	325.65	325.2



APPENDIX E - BASELINE ADJUSTMENT MINIMUM REQUIREMENTS

Each Baseline Adjustment request will contain the following information:

- Participant Name
- Facility number as stated in Application Form
- Facility address
- Facility name (if applicable)
- The period used to develop the Baseline Model
- The period for which the Baseline Adjustment is requested (temporary or permanent)
- A description of the change in the building or building operations requiring the Baseline Adjustment
- Annual consumption of calculated Baseline Adjustment (kWh)
- Baseline Adjustment as percentage of average baseline period use
- Baseline Adjustment values for each months of the Pay-for-Performance Period to date
- Identification of the basis for calculations (submeter data and/or engineering calculations)
- A description of the requested Baseline Adjustment including details of all metering and/or calculations
- Any calculation provided in spreadsheet form

APPENDIX F – GLOSSARY OF TERMS

The following terms are used throughout this document:

Approved Meter has the meaning as ascribed in Section 4.6 of this document.

Average Peak Demand Savings means the average load reduction in electricity demand between the Baseline Period and the Pay-for-Performance Period occurring between 1:00pm – 7:00pm Eastern Daylight Time (EDT) or 12:00pm – 6:00pm Eastern Standard Time (EST) during all days from June 1 through August 31, inclusive, that are not a weekend or Federal/Provincial holiday.

Baseline Adjustment means a change to the Baseline Model necessitated by a Baseline Adjustment Event. A Baseline Adjustment may be understood as Non-Routine Adjustment as defined in Efficiency Valuation Organization's International Performance Measurement and Verification Protocol (IPMVP) Core Concepts, October 2016, EVO 10000 – 1:2016 and IPMVP Application Guide on Non-Routine Events & Adjustments October 2020, EVO 10400 – 1:2020

Baseline Models means the Facility-specific model or set of models, submitted with the Participant's Facility Application Form, as approved by IESO, that predict the energy consumption and peak demand of a Facility over a set period of time in the absence of Eligible Measures, using the Baseline Model Requirements.

Baseline Period means the period used to derive the Baseline Model.

Coefficient of the Root Mean Square Error (CV-RMSE) means the standard deviation of errors of prediction above the regression line normalized by the average *y* value. Please refer to Efficiency Valuation Organization's International Performance Measurement and Verification Protocol (IPMVP) Core Concepts, October 2016, EVO 10000 – 1:2016

Net Determination Bias Error (NDBE) means the percentage error in energy use predicted by the model compared to actual energy use.

Pay-for-Performance Period means a 12-month period during which the Participant implements and/or maintains Eligible Measures for a Facility and during which Electricity Savings will be measured, provided that the final Pay-for-Performance Period shall be adjusted so as to terminate on the final day of the Term. A facility's consecutive Pay-for-Performance Periods represent the "Reporting Period" as defined by the Efficiency Valuation

Technical Reviewer means a third party retained by the IESO.

R^2 (Coefficient of Determination) means a statistical indication of the proportion of the variance in the dependent variable that is predictable based on changes in the independent variable. R^2 values range between 0 and 1, with a higher R^2 indicating a higher proportion of the variance in the dependent variable being predictable from the independent variable. Please refer to IPMVP Volume 1 (2012) for further reference.

Organization's International Performance Measurement and Verification Protocol (IPMVP) Core Concepts, October 2016, EVO 10000 – 1:2016

Standard Error of the Coefficient (intercept or slope) means The standard error is an estimate of the standard deviation of the coefficient. For simple linear regression, it is calculated separately for the slope and intercept. Please refer to Efficiency Valuation Organization's International Performance Measurement and Verification Protocol (IPMVP) Core Concepts, October 2016, EVO 10000 – 1:2016

T-Statistic means a statistical indication of the significance of a coefficient for linear regression. The larger the t-statistic, the more significant the coefficient is to estimating the dependent variable. The coefficient's t-statistic is compared with the critical t-statistic (t_{crit}) associated with the required confidence level and degrees of freedom. For large sample sizes and 95% confidence level, t_{crit} is approximately 2. The t-statistic for a coefficient is found by dividing the coefficient by its standard error. Please refer to Efficiency Valuation Organization's International Performance Measurement and Verification Protocol (IPMVP) Core Concepts, October 2016, EVO 10000 – 1:2016