action matters for business

i am your guide

Project Impact Assessment Measurement and Verification (PIAM&V) Tool

NSW GOVERNMENT Office of Environment & Heritage

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Executive summary

This guide details how to use the Project Impact Assessment with Measurement and Verification (PIAM&V) Tool[1] to calculate Energy Savings for a Recognised Energy Saving Activity (RESA) under the NSW Energy Savings Scheme (ESS).

Specifically, this user guide provides information on the use of version 2.1 of the PIAM&V Tool to calculate Energy Savings in the context of clause 7A.1(a) of the ESS Rule, for forward creation for a single Site model, with energy models developed under:

- clause 7A.2(a)(i) using Estimate of the Mean, or
- clause 7A.2(a)(ii) using Regression Analysis.

This guide should be used by:

- applicants who are seeking accreditation for a RESA and plan to use the PIAM&V Tool, and
- users already accredited (Accredited Certificate Providers) under PIAM&V who want to use the PIAM&V Tool to assist them in accurately calculating Energy Savings for an Implementation under their RESA

The guide should be read in conjunction with the IPART Application Guide for ESS Accreditation[2] and the IPART Method Guide PIAM&V[3].

In addition to this user guide, the following references are recommended reading before completing the Tool and submitting an application for accreditation:

- The Measurement and Verification Operational Guide published by the NSW Office of Environment and Heritage[4], and
- International Performance Measurement and Verification Protocol Core Concepts 2016 (IPMVP), published by Efficiency Valuation Organization[5].

1 Available at http://www.environment.nsw.gov.au/business/piamv-tool.htm

2 Available at http://www.ess.nsw.gov.au/How_to_apply_for_accreditation

3 Available at http://www.ess.nsw.gov.au/Methods_for_calculating_energy_savings/Project_Impact_Assessment_with_MV

4 Available at http://www.environment.nsw.gov.au/energyefficiencyindustry/confirm-energy-savings.htm

5 Available at http://www.evo-world.org

1 Introduction

The PIAM&V Tool is a Microsoft Excel template with in-built formulas and routines used to calculate Energy Savings following the PIAM&V Method under the ESS.

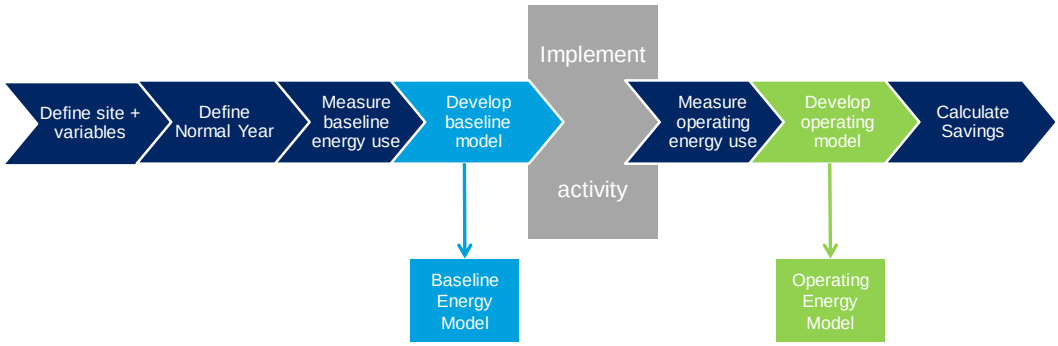
This guide is structured around the PIAM&V Tool layout and the process of implementing a PIAM&V project, as represented in Figure 1-1. The Tool can calculate Electricty Savings, or Gas Savings, or both for fuel switching projects. Separate Energy Models must be developed to calculate Electricity Savings and Gas Savings. Therefore Steps 1 to 10 of the Tool are divided into Electricity and Gas worksheets, with identical functionalities.

The guide applies to both the Electricity and Gas worksheets in Chapter 3 to Chapter 14. The form(s) of energy used in the project is selected in the Project Summary Sheet and this determines which sheets must be completed to calcuate Energy Savings.

The Tool is designed to be completed progressively throughout the measurement and verification process. The Tool can only estimate Energy Savings once all sections have been completed, i.e. after the project has been implemented and an Operating Energy Model developed. However, partially completed versions of the Tool may be submitted as part of an application for accreditation – refer to the IPART Method Guide PIAM&V for more details.

The Tool can also be used to just calculate Decay Factors using the Persistence Model. This option is also chosen in the Project Summary sheet.

Figure 1-1 Development of baseline and operating energy models from measurements



1.1 Computer system minimum requirements

The minimum requirements to run the PIAM&V Tool are:

- Windows 7 operating system or later
- Windows Microsoft Office Excel 2010 or later .

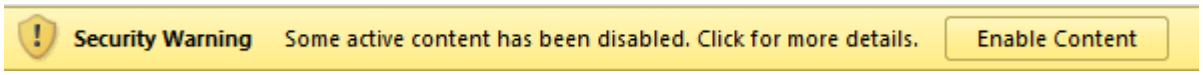
Note: The Tool is not supported on Microsoft Office for Mac.

The following computer settings will enable the correct running of the Tool:

- Macros and active content must be enabled when the Tool is opened. Macro settings can be changed in Excel 2010 in the Macros tab in the Trust Centre (accessed under the File>Options menu item). The recommended setting is 'Disable all macros with notification'.

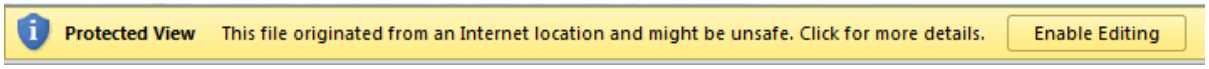
The following warning will then appear, and 'Enable Content' must be selected for the Tool to work correctly.

Figure 1-2 Security warning message



- Depending on Trust Centre settings, the Tool may open in Protected View. To exit Protected View and edit the Tool, 'Enable Editing' must be selected when the yellow message bar appears. After you leave Protected View, the Tool becomes a trusted document.

Figure 1-3 Protected view warning message



- The location to which the Tool is saved from may need to be added to the Excel Trusted Locations list to ensure full functionality. Trusted Location settings can be changed in Excel 2010 in the Trusted Location tab in the Trust Centre.

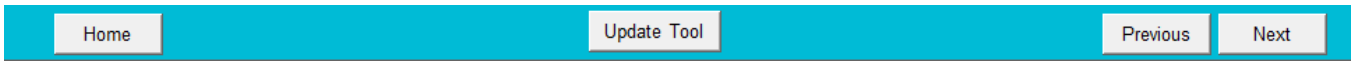
1.2 Tool navigation and functions

The Tool has the following navigational and functional options:

Menu Page – Click buttons to navigate to various sheets on the Tool.

Navigation Bar –On each sheet, the Tool has the following navigational options:

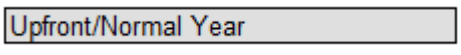
Figure 1-4 Navigation bar of the Tool



- Home – Return to menu page
- Update Tool (where relevant) – Updates the Tool based on the inputs. This function is discussed further in section 1.2.1.
- Previous – Return to the previous sheet on the Tool
- Next – Move to the next sheet on the Tool.

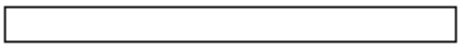
Locked input cells – These are coloured grey and indicate inputs that are locked at this value for this version of the Tool, e.g.

Figure 1-5 Example of a locked input cell



Unlocked input cells – These are coloured white and usually require a numeric input value, e.g.

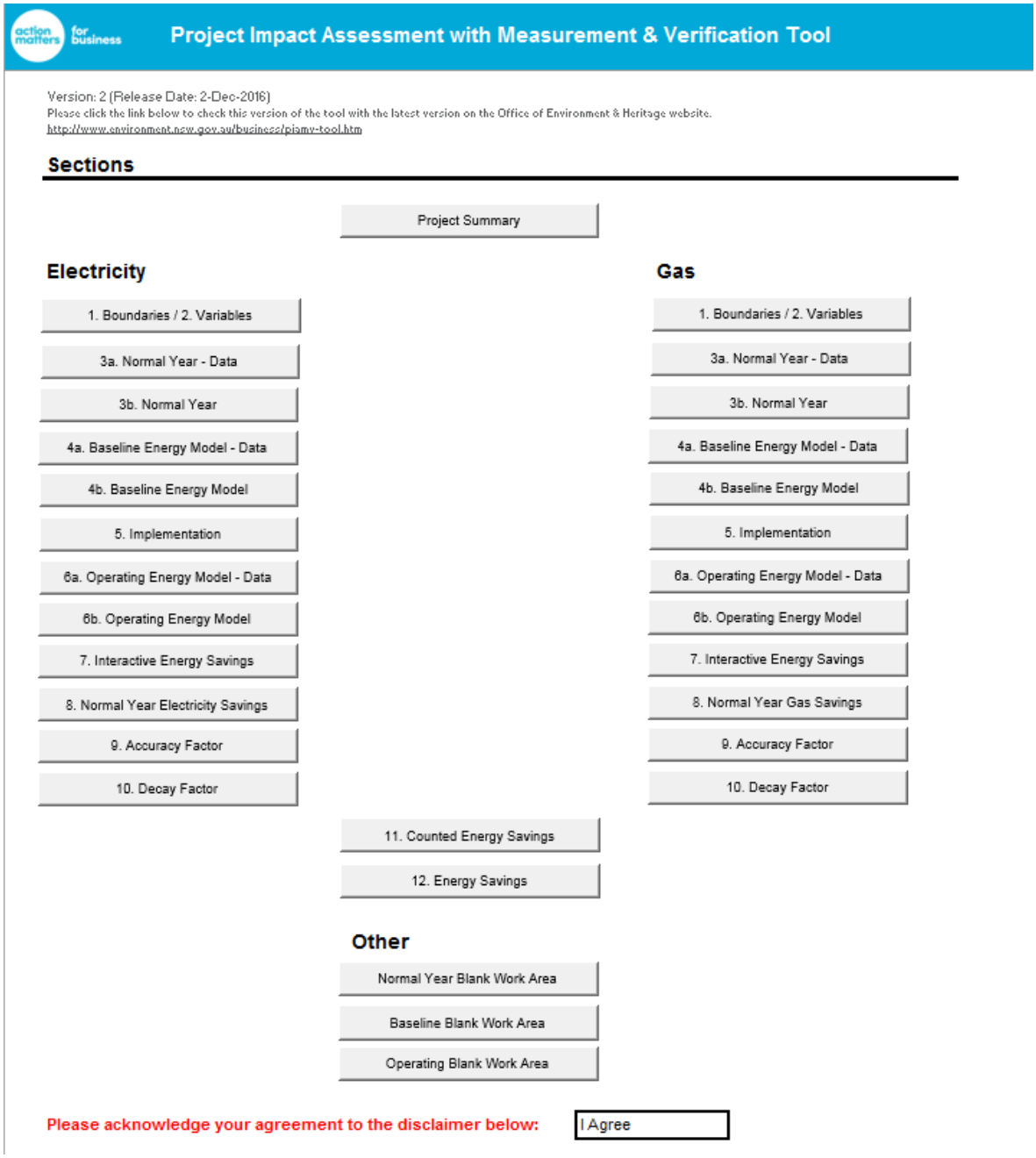
Figure 1-6 Example of an unlocked input cell



Description input boxes – These are larger, free text input cells, usually used for text descriptions, e.g.

Figure 1-7 Example of a description input box

Figure 1-8 Menu page of the Tool



Critical information boxes – These are locked boxes that highlight key information to assist the user, e.g. where the Tool is missing information.

Figure 1-9 Example of a critical information box

NB: Click the 'Update Tool' button in the navigation bar above after entering the data. This step should contain 35040 data points based on the selected 15 Minutes Measurement Frequency.

Warning boxes - These are locked boxes that warn users when the energy models do not meet the guideance on thresholds of statistic good-fit (refer to IPART Method Guide PIAM&V[6] Appendix D, table D-2) . When warning messages appear, users can still calculate ESCs, but should document the steps taken in developing the energy models to support the final form of the model and to allow for review by the M&V Professional.

Figure 1-10 Example of a warning message

Warning: The 'Operating Energy Model - Data (Electricity)' is not continuous or covers a short period. Please ensure that the M&V Professional has examined your data and approved your M&V Plan.

Error boxes - These are locked boxes that provides information to user on why the Number of Certificates is not calculated when entered data do not meet Rule requirements. Users need to review the data they entered or the Number of Certificates will not be calculated. Examples of errors include when the Coefficient of Variation of the energy consumption over the Measurement Period is above 15% when users using Estimate of the Mean to establish energy models.

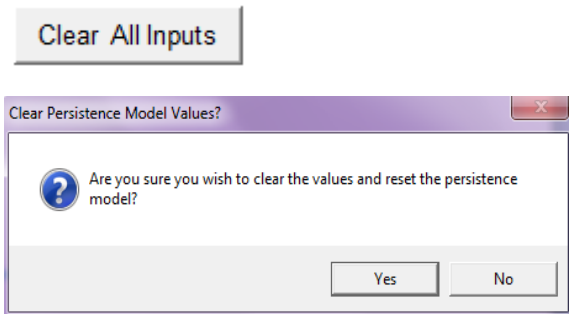
Figure 1-11 Example of an error box

Error: The 'Number of Certificates' cannot be calculated because the following criteria has not been met.

- Step 4b: Baseline Energy Model (Electricity) - Coefficient of Variation exceeds 15%.

Clear All Inputs – Removes all inputs and resets the Persistence Model. This is only available on Step 10 of the Tool when using the Persistence Model. Clicking on this button generates a confirmation message before inputs are reset.

Figure 1-12 Image of the "Clear All Inputs" button and the warning message



1.2.1 Update Tool process

The Tool is required to be updated at specific intervals when data insertion has occurred. This is only required for specific sheets on the Tool and a warning/critical information box is provided as a reminder each time this is required.

Some charts and formulas also require the Tool to be updated. Where this is the case, an update button is provided.

6 Available at http://www.ess.nsw.gov.au/Methods_for_calculating_energy_savings/Project_Impact_Assessment_with_MV

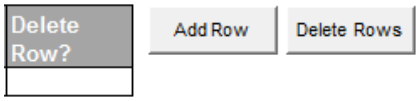
1.2.2 Adding and removing table rows

Where the tool contains a table, the ability to add and delete rows may be provided.

Click the 'Add Row' button to add an additional row.

To delete rows, select 'Y' from the 'Delete Row' column drop-down box for each row to be deleted, and then click the 'Delete Rows' button.

Figure 1-13 Add/delete row function



1.2.3 Work Area Sheets

The Tool includes three blank sheets:

- Normal Year Blank Work Area
- Baseline Blank Work Area
- Operating Blank Work Area.

These sheets can be used for supplementary calculations, data manipulation and supporting information as required.

To link to cells on these sheets, use the sheet name reference in the information box on the specific sheet, together with the cell reference required.

1.3 Check for the latest version of the Tool

Please ensure you are using the latest version of the Tool by following the link on the Home Page (http://www.environment.nsw.gov.au/business/piamv-tool.htm).

1.4 Using this guide

Version 2.0 onwards of the tool allows energy models developed from either a Regression Analysis or Estimate of the Mean. Some sections are only relevant to one type of energy model. For your convenience, Section 6 and Section 10 of the guide have been marked with the following symbols.

Figure 1-14 Symbols for Regression Analysis and Estimate of the Mean

Symbol	Energy Model
R	Regression Analysis
E	Estimate of the Mean

2 Project Summary Sheet

ACP Name

Enter the Accredited Certificate Provider (ACP) Name as per the Application Form: Part A – General details.

RESA Identifier

Enter the RESA identifier, as per the RESA application form.

Site Name

Enter the name of the Site for which the PIAM&V Tool is being completed.

Site Address

Enter the full address of the Site for which the PIAM&V Tool is being completed.

What do you want to use the tool for?

Please select either "Full energy savings calculations" or "Decay factor only using Persistence Model"

If selecting "Decay factor only using Persistence Model", then the tool will be navigated to Step 10 when clicking "next" at the navigation bar. This function is designed to be used by users to view Decay Factors when Persistence Model is being used.

What form of energy is used in this project?

Please select either "Electricity only", "Gas only", or "Electricity and Gas". The tool will calculate energy savings from either electricity or Gas or both depending on the selection.

Brief overview of RESA

Provide a description of the RESA and the Implementation at the Site.

Multisite RESA

Select an item from the drop down list:

- YES, if the RESA will include multiple Sites; or
- NO, if the RESA will only apply to a single Site.

Note that the PIAM&V Tool must be completed separately for each Site for both single Site and multi-Site RESAs. A sampling approach is not currently supported by the PIAM&V Tool.

Method for developing energy models

For Version 2.0 onwards of the Tool, the method for developing the Gas or electricity Baseline Energy Model and Operating Energy Model can be 'Regression Analysis' or “Estimate of the Mean” (refer to Appendix D, Section D.3.3 of the IPART Method Guide PIAM&V[7]). Different methods can

[7] Available at http://www.ess.nsw.gov.au/Methods_for_calculating_energy_savings/Project_Impact_Assessment_with_MV

be used for the Baseline Energy Model and the Operating Energy Model in the same Implementation. Select a method for both the Baseline Energy Model and Operating Energy Model for each form of energy used in the project as identified above.

Calculation sub-method

For Version 2.0 onwards of the Tool, the calculation sub-method must be 'Upfront/Normal Year' and the selection for this input is locked at this value.

Gas used in fuel switching activity (if applicable)

If the activity is a fuel switching activity (between electricity and Gas), the type of Gas needs to be selected.

Estimated number of certificates

This is a locked calculation field displaying the estimated number of Energy Saving Certificates that could be created from this Site, and is linked to the value on the Energy Savings Sheet (see section 16).

A value will only be displayed at this location once all input conditions are met. Refer to section 16 for a description of the error messages that may be displayed.

Note that the actual number of Energy Saving Certificates approved for creation may be different from the estimate shown.

When first using this Tool, an error message box may appear under this box. Please ignore this error box at this stage, as it will disappear once all criteria are met.

Name of Energy Saver

Enter the name of the Original Energy Saver, or Nominated Energy Saver. Refer to section 3.1 of the IPART Method Guide PIAM&V.

Cost to the purchaser (ex GST)

Enter the cost to the Purchaser in the table, excluding GST. If the project has multiple parts, enter the cost of each part.

Additional rows may be added or removed from the table as described in section 1.2.2.

Type of end user services for which energy was saved

Select the end user services for which energy will be saved at the Site from the drop-down list, and estimate the expected annual savings following Implementation, as a percent of the total annual baseline energy use, for each end user service. Enter values including the '%' symbol, or as a fraction. E.g. for ten percent, enter '10%' or 0.1.

Additional rows may be added or removed from the table as described in section 1.2.2.

Total estimated savings as % of baseline energy

The estimate of the total annual savings expected following Implementation of the project, as a percent of total annual baseline energy use, is calculated automatically based on the sum of the rows in the preceding table. An end user service must be defined for each row before it can be included in the sum.

This total is used to estimate a value for the Accuracy Factor following the development of the Baseline Energy Model (see section 0).

Australian Business Number of end user

Enter the Australian Business Number of the end user (Original Energy Saver).

Business classification of end user

Select the business classification of the end user (Original Energy Saver) from the drop-down box of options, which are based on Table A18 of the ESS Rule.

Implementation date

Enter the Implementation date of the project. See section 3.3 of the IPART Method Guide PIAM&V for requirements for determining and evidencing the Implementation date.

If the PIAM&V Tool is being completed prior to Implementation this may be the expected Implementation date. In this case, ensure the date is updated to the actual Implementation date following Implementation.

From Step 1 to Step 10 (Section 3 - 14 of this guide), the Tool is divided into Electricity and Gas sections, with identical functions. Section 3 to Section 14 of this guide covers both Electricity and Gas calculations.

3 Boundaries and Variables Sheet

3.1 Step 1 – Define Site, Activity and Boundary

Site Name

This field is linked to the Site Name entered on the Project Summary Sheet and is locked.

Describe activity

Enter a description of the activity as per the requirements in section 2.2 of the Application Guide for ESS Accreditation.

Define Measurement Boundary, including End-User Equipment to be measured

Define the Measurement Boundary, including End-User Equipment to be measured. Refer to section 3.3 of the Method Guide: PIAM&V and section 2.2 of the Application Guide for ESS Accreditation.

3.2 Step 2a – Define Energy Model Data Frequency

Measurement Frequency

Select the measurement frequency for the models from the drop-down list. Both the Energy Model and and the Operating Energy Models need to be based on the same frequency of data. The measurement frequency defines how many data points are required for a Normal Year.

After changing the measurement frequency, you will be prompted to update the tool, or press the 'Update Tool' button in the navigation bar.

3.3 Step 2b – Define Variables

3.3.1 Energy Consumption

Identify and define how Energy Consumption, E, will be calculated based on meter data.

Energy can be determined through multiple meters, but these must be totalled and entered as one energy data series for both the Baseline Energy Models and Operating Energy Models (see sections 6.1 and 9.1).

The table requires the following inputs:

Meter Identifier/Name – Enter an identifier or name for the meter, for example the National Meter Identifier (NMI) for a utility meter.

Units – The units of each meter must be in MWh for electricity and GJ for Gas. Data measured in other units must be converted to MWh or GJ before values are entered into the model.

Description – Enter the details of the meter, including any relevant manufacturer specifications if it is not a utility meter.

How Measured/Calculated – Describe how the data is retrieved from the meter, and any calculations performed (automatically or manually) on the raw data to determine the measured value in MWh for electricity or GJ for Gas.

Conversion to Model Frequency – Describe any conversion of measured data to be consistent with measurement frequency defined for the Tool in section 3.2.

Measurement Accuracy – Select the accuracy type (either 'relative error' or 'absolute error') for each meter, and then enter the Margin of Error specified for the meter. Utility meters should be entered as having an 'absolute error' of zero.

Additional rows may be added or removed from the table as described in section 1.2.2.

3.3.2 Independent Variables

Identify and define p Independent Variables, which vary over time under normal operating conditions, and must be measured during Measurement Periods for Regression Analysis.

The PIAM&V Tool requires that the Baseline and Operating Energy Models are developed with the same Indpendent Variables. After changing the Independent Variables, click the 'Update Tool' button in the navigation bar.

The table requires the following inputs:

Independent Variable name – Enter a name for the Independent Variable. This name will be used as a label for the Independent Variable in the baseline and operating model sheets..

Units – Enter the unit of measurement used for the Independent Variable in the energy models.

Description – Provide a description of the Independent Variable, including how the measurements are taken, any relevant manufacturer specifications, calibration procedures etc.

How Measured/Calculated – Describe how the raw data is measured, retrieved and stored, and any calculations performed (automatically or manually) on the raw data to determine the Independent Variable values.

Conversion to Model Frequency – Describe any conversion of measured data that was performed to be consistent with the measurement frequency defined for the Tool in section 3.2.

Measurement Accuracy – Select the accuracy type (either 'relative error' or 'absolute error') for each Independent Variable, and then enter the Margin of Error for the Independent Variable.

Additional rows may be added or removed from the table as described in section 1.2.2.

3.3.3 Standard operating conditions

Identify and define q Site Constants. These do not vary over time for each site under normal operating conditions, but could change under extraordinary circumstances (such as unscheduled maintenance), and so must also be monitored and measured during Measurement Periods.

After changing the Site Constants, click the 'Update Tool' button in the navigation bar.

The table requires the following inputs:

Site Constant name – Enter a name for the Site Constant. This name will be used as a label for the Site Constant in the baseline and operating model sheets.

Units – Enter the units of measurement used for the Site Constant. This must be the units after any conversion of the measured data, if required.

Description – Provide a description of the Site Constant, including how the measurements are taken, any relevant manufacturer specifications, calibration procedures etc.

How Measured/Calculated – Describe how the raw data is measured, retrieved and stored, and any calculations performed (automatically or manually) on the raw data to determine the Site Constant values.

Conversion to Model Frequency – Describe any conversion of measured data that was performed to be consistent with the measurement frequency defined for the Tool in section 3.2.

Typical value – Enter the value of the Site Constant under normal operating conditions.

Measurement Accuracy – Select the accuracy type (either 'relative error' or 'absolute error') for each Site Constant, and then enter the Margin of Error for the Site Constant.

Additional rows may be added or removed from the table as described in section 1.2.2.

Other variables excluded from model

These are variables for which data is available, but which are either dependent on other variables or do not have a strong influence on energy consumption and so have not been included in the model. Include a reason for the exclusion of each variable.

The table requires the following inputs:

Name – Enter the name of the excluded variable.

Description – Provide a description of the variable, including how the measurements are taken, any relevant manufacturer specifications, calibration procedures etc.

How Measured/Calculated – How the raw data is measured, retrieved and stored.

Value (if constant and known) – Enter the typical value of the variable under normal operating conditions.

Reason Excluded from Model – Enter a brief explanation for the variable's exclusion from the model.

Additional rows may be added or removed from the table as described in section 1.2.2.

4 Normal Year Data Sheet

4.1 Step 3a – Establish Normal Year of Operating Conditions Data

The values of Independent Variables and Site Constants are entered on this sheet for the entire Normal Year. The names of the columns are automatically updated based on the Independent Variable and Site Constant names entered in the Boundaries and Variables sheet.

The information box shows the number of data points required, based on the selected measurement frequency entered in section 3.2.

The table for data entry is automatically formatted with borders to indicate how many data points are required, based on the selected measurement frequency. A full year of data is required for each parameter.

Enter the datestamp/timestamp value as the date/time of the beginning of the interval for each data point, based on the measurement frequency.

If pasting data into this sheet from another workbook, it is recommended that the *Paste special* > *Values* command is used.

5 Normal Year Sheet

5.1 Step 3b – Establish Normal Year of Operating Conditions

5.1.1 Define a Normal Year of operation

Describe how the Normal Year is defined

Provide an overall description of how the Normal Year is defined.

Define the data sources and how they were manipulated

Provide the following values in this section.

- Data sources, and
- How they were manipulated to determine the Normal Year data set (if at all).

For example, cooling degree days may be calculated from a set of Typical Meteorological Year temperature data derived from a nearby Bureau of Meteorology station.

Complete the table for each data source. Additional rows may be added or removed from the table as described in section 1.2.2.

If the operating cycle is less than one year, describe how the operating cycle is extended to cover a full Normal Year

An operating cycle refers to the average time period for a site or energy system to complete one cycle of energy usage patterns, taking into account the effects of key influencing variables. If the operating cycle is less than one year, describe how the operating cycle is extended to cover a full Normal Year.

Describe how the raw data is used to establish the normal year (optional)

Include any other additional information regarding how raw data is used to establish the normal year.

5.1.2 Data set

This section checks the values entered on the Normal Year data sheet.

Number of data points

The number of data points is automatically calculated from data entered in the Normal Year data sheet.

A warning message will be displayed if the required number of data points is not entered to complete a full year long data set based on the selected measurement frequency entered in section 3.2. The number of data points should be based on 365 days, i.e. not a leap year.

Calculated range of normal year operating conditions

A table automatically calculates the maximum and minimum range of the Normal Year data set for each Independent Variable.

To ensure maximum Energy Savings, Baseline and Operating Energy Models developed using Regression Analysis should be developed to have an Effective Range that covers all Normal Year data (see section 7.1.4).

6 Baseline Energy Model Data Sheet

6.1 Step 4a –Baseline Energy Model Data

Enter the values for the entire baseline Measurement Period for energy use, Independent Variables and Site Constants to be used to develop the baseline energy model data.

The data entered must be the same data used to develop the baseline energy model, but should also include any measurements that were removed as non-routine measurements before the model development.

The names of the columns are automatically updated based on the Independent Variable and Site Constant names entered in the Boundaries and Variables sheet.

Energy must be entered in units of MWh for electricity and GJ for Gas, and must be the total measured energy use for the system within the measurement boundary.

If the Baseline Energy Model is being developed using Estimate of the Mean, values of Independent Variables are not required, but it is recommended to measure and enter these values in the Tool.

Enter the datestamp/timestamp value as the date/time of the beginning of the interval for each data point, based on the measurement frequency.

Each datestamp/timestamp value must be equal to one measurement frequency period later than the previous one. For example, if the measurement frequency is monthly, each data point must be one month later than the previous one.

For each data point, if the measurement was removed from the data set before the energy model is established because it was a non-routine measurement, enter a 'Y' for that row in the column titled 'Exclude non-normal measurement?'. Enter a reason for the exclusion of the data point.

If pasting data into this sheet from another workbook, it is recommended that Paste special > Values command is used.

Click the 'Update Tool' button in the navigation bar after entering the data.

7 Baseline Energy Model Sheet

7.1 Step 4b – Establish Baseline Energy Model

This worksheet is used to enter the results of the model developed from the data in the Baseline Energy Model Data sheet. Different fields are shown depending on the method for developing the Baseline Energy Model(s) on the Project Summary sheet.

Note that the Tool does not automatically perform the Regression Analysis, i.e. it must be conducted separately. It is possible to perform the regression on the Baseline Work Area sheet manually, using the Excel regression procedure in the Data Analysis add-in. The Regression Analysis may also be performed using a suitable statistical software package.

The Tool requires that the resulting regression equation be linear in the coefficients and Independent Variables, but the equation may have single or multiple independent variables.

If the Estimate of the Mean method is chosen in the Project Summary Sheet, the Tool automatically calculates the Estimate of the Mean based on the Baseline Energy Model Data entered in Step 4a.

7.1.1 Part 1 - Measure energy consumption and Independent Variables and monitor Site Constants over the Measurement Period

The Tool automatically calculates the start date, end date, Measurement Period (in years) and number of measurements in the Measurement Period, based on the data previously entered in the Baseline Energy Model Data sheet and the selected measurement frequency.

There are no limits to the length of the Measurement Period. However, the Measurement Period chosen should consider the operating cycle and range of values expected for Independent Variables to ensure that all values are captured without excessive duplication.

7.1.2 Part 2 - Remove measurements taken under non-routine site conditions

Based on the data marked as non-routine measurements on the Baseline Energy Model Data sheet, the Tool automatically calculates the number of measurements removed, the number of remaining measurements, and calculates the Non Routine Adjustments as a proportion of the Measurement Period. As per Clause 7A.5(g) of the ESS Rule, this proportion must be less than 20%. If more than 20% measurements are removed, an error message is displayed and ESCs will not be calculated.

7.1.3 Part 3 - Analysis: Test for correlation between Independent Variables

The Tool automatically tests for correlation between the measured values of the variables, by calculating the Pearson's correlation coefficient (using the CORREL function) for each pair of Independent Variables.

Any variables that are strongly correlated (i.e. which have a Pearson's correlation coefficient > 0.5) are highlighted red.

For any pairs of strongly correlated Independent Variables, it is recommended that only one of the variables is in included in the regression model. Users can choose to use the existing Independent Variables but explantions need to be provided.

7.1.4 Part 4 - Determine effective range and degrees of freedom

Analysis - Effective range of baseline energy model

This section automatically calculates the effective range of the Baseline Energy Model using the bounding box method. For each Independent Variable, the effective range for the baseline Measurement Period is determined by maximum and minimum values, defined as:

- $x_j.max = max(x_j(t))$
- $x_j.min = min(x_j(t))$

where $x_j(t)$ is the value of the Independent Variable x_j measured during time period t.

The Tool then displays the Baseline Measurement Period Effective Range for each Independent Variable next to the range of the Normal Year values for that Independent Variable.

Analysis - Calculated effectiveness of basleine energy model

R

The percentage of the Normal Range that falls within the Baseline Measurement Period Effective Range is calculated based on the Independent Variable with the smallest Baseline Measurement Range, and has a maximum value of 100%.

Energy savings are maximised when 100% of the Normal Range is within Baseline Measurement Period Effective Range.

When less than 100% of the Normal Range is within the Baseline Measurement Period Effective Range, data points where the Normal Year value is outside the Baseline Measurement Period Effective Range will be automatically excluded from the Normal Year Energy Savings calculation in section 12.1.

In the table below the percentage of Normal Range within Baseline Measurement Range, four items are relavent to Regression Analsyis.

- # of valid data points
- # of independent variables
- Degrees of freedom
- Ratio # valid data points to # independent variables

The degrees of freedom are automatically calculated based on the number of valid data points and the number of independent variables.

The tool also examines the ratio of the number of valid data points to the number of independent variables. As per Clause 7A.2(a)(ii) of the Rule, the number of independent observations (valid data points) must be at least the sum of six times the number of Independent Variables. If this requirement is not met, an error message will be displayed and the Number of Certificates will not be calculated.

E

The Tool calculates the Coefficient of Variation automatically based on the energy consumption valeus entered in the Baseline Energy Model Data sheet. As per Clause 7A.2(a)(i) of the Rule, the result must be below 15%. If this requirement is not met, an error message will be displayed and the Number of Certificates will not be calculated.

7.1.5 Part 5 - Build energy model

This section is used to record the results of the Regression Analysis/Estimate of the Mean analysis performed on the data in the Baseline Energy Model Data sheet.

The software/tool used to generate your regression equation

Enter the name of the software or tool used to generate the regression equation, including the version number where relevant. This is not relevant if you are using the Estimate of the Mean.

Model parameters

R

Enter the results of the Regression Analysis in the table as:

- Variable – variable names are automatically included from defined names provided in section 3.3. The intercept is also included.
- Coefficient – Enter the value of the coefficient for the variable as determined from the Regression Analysis.
- t-statistic - Enter the value of the t-statistic for the variable as determined from the Regression Analysis.
- Check – For each Independent Variable (but excluding the intercept) the value of the t-statistic is compared to the best practice benchmarks. Project proponents need to provide written justifications if any test result is “Warning”.

Values entered must correspond to the output of the Regression Analysis from the software or tool used.

E

The Tool calculates the Estimate of Mean automatically. The calculated value of the Estimate of the Mean will display at this section in the "Coefficient" column of the "Intercept". The value is locked.

Working Formula

R E

The working formula is automatically displayed when the ‘update’ function is selected. The formula uses Independent Variable names and coefficient values for each Independent Variable and the intercept entered above.

The 'Update' procedure must be run to update the working formula after entering or changing any values in the analysis table.

Chart

R E

The chart automatically displays the time series of the measured baseline energy (blue series), and compares it against the modelled baseline energy (grey series) for the baseline Measurement Period.

Values marked as non-routine measurements are not plotted.

The 'Update' procedure must be run to update the chart after entering or changing any values in the analysis table.

7.1.6 Part 6 – Statistical analysis

Statistical analysis output

R

Enter the following results from the Regression Analysis:

- Coefficient of determination (R^2)
- Adjusted R^2
- Standard error (SE).

Values entered must correspond to the output of the Regression Analysis from the software or tool used.

E

The Tool automatically calculates the standard error.

R E

Based on the values, the Tool automatically calculates the:

- t-value (at 90% confidence level)
- baseline average modelled energy
- absolute modelling precision
- relative modelling precision (based on mean value).

Analysis – Check the baseline energy model meets best practice benchmark

R

The Tool automatically checks the results of the Regression Analysis of Baseline Energy Model against the best practice benchmarks, and displays 'pass' or 'fail' based on the following parameters:

- t-statistics of independent variables – 'Pass' if all t-statistics of Independent Variable coefficiencts are >2, or 'warning' otherwise.
- Lesser of R^2 or adjusted R^2 – 'Pass' if the result is >0.75; 'warning' otherwise.
- Relative precision calculated at 90% confidence level – 'Pass' if the result is <±100%; 'warning' otherwise.

If 'Warning' is shown for any checks of the Regression Analysis results above, you will need to provide written justification on the energy model in your M&V plan.

Analysis - Estimated accuracy factor

R E

This section allows the user to estimate the Accuracy Factor that could be applied in section 13 of this guide, after the generation of the Baseline Energy Model, but before the generation of the Operating Energy Model. This may assist in project development before accreditation.

This section requires the user to enter an estimated standard error value for the Operating Energy Model. This value must be expressed in the same units as the Baseline Energy Model standard error.

The Tool then calculates a number of values to achieve an estimated Accuracy Factor between 0 and 1.

The estimated Accuracy Factor can be used to assist in planning the M&V for the operating period. Energy Savings are calculated using the Accuracy Factor calculated in section 13 only.

8 Implementation Sheet

8.1 Step 5 - Implement and Commission Activity

Implementation date

The Implementation Date is automatically linked to the value entered in Section 2 Project Summary Sheet. Start and end dates for each Implementation year are calculated from this date.

If an estimated Implementation Date was entered in Section 2 Project Summary Sheet, this value must be updated to the actual Implementation Date following Implementation.

9 Operating Energy Model Data Sheet

9.1 Step 6a –Operating Energy Model Data

Enter the values for the entire Operating Measurement Period. These values include energy use, Independent Variables and Site Constants used to develop the Operating energy model data.

The data must be the same as that used to develop the Operating energy model through Regression Analysis or Estimate of the Mean analysis, but it must also include any non-routine measurements that were removed before the analysis.

The names of the columns are automatically updated based on the names of the Independent Variables and Site Constants entered in the Boundaries and Variables sheet.

Energy must be entered in units of MWh for electricity and GJ for gas, and must be the total measured energy use for the system within the measurement boundary.

Enter the datestamp/timestamp value as the date/time of the beginning of the interval for each data point based on the measurement frequency.

Each datestamp/timestamp value must be equal to one measurement frequency period later than the previous one. For example, if the measurement frequency is monthly, each data point must be one month later than the previous one.

For each data point, if the measurement was removed from the data set before the analysis because it was a non-routine measurement, enter a 'Y' for that row in the column titled 'Exclude non-normal measurement?'. Enter a reason for the exclusion of the data point.

If pasting data into this sheet from another workbook, it is recommended that Paste special > Values command is used.

Click the 'Update Tool' button in the navigation bar above after entering the data.

10 Operating Energy Model Sheet

10.1 Step 6b – Establish Operating Energy Model

This worksheet is used to enter the results of the model developed from the data in the Operating Energy Model Data sheet. Different fields are shown depending on the method for developing the Operating Energy Model(s) on the Project Summary sheet.

Note that the Tool does not automatically perform the Regression Analysis, i.e. it must be conducted separately. It is possible to perform the regression on the Operating Work Area sheet manually, using the Excel regression procedure in the Data Analysis add-in. The Regression Analysis may also be performed using a suitable statistical software package.

The Tool requires that the resulting regression equation be linear in the coefficients and Independent Variables, but the equation may have single or multiple independent variables.

If the Estimate of the Mean method is chosen in the Project Summary Sheet, the Tool automatically calculates the Estimate of the Mean based on the Operating Energy Model Data entered in Step 4a.

10.1.1 Part 1 - Measure energy consumption and Independent Variables and monitor Site Constants over the Measurement Period

The Tool automatically calculates the start date, end date, Measurement Period (in years) and number of measurements in the Measurement Period, based on the data previously entered in the Operating Energy Model Data sheet and the selected measurement frequency.

There are no limits to the length of the Measurement Period. However, the Measurement Period chosen should consider the operating cycle and range of values expected for Independent Variables to ensure that all values are captured without excessive duplication.

10.1.2 Part 2 - Remove measurements taken under non-routine site conditions

Based on the data marked as non-routine measurements on the Operating Energy Model Data sheet, the Tool automatically calculates the number of measurements removed, the number of remaining measurements, and calculates the Non Routine Adjustments as a proportion of the

Measurement Period. As per Clause 7A.5(g) of the ESS Rule, this proportion must be less than 20%. If more than 20% measurements are removed, an error message is displayed and ESCs will not be calculated.

10.1.3 Part 3 - Analysis: Test for correlation between Independent Variables

R

The Tool automatically tests for correlation between the measured values of the variables, by calculating the Pearson's correlation coefficient (using the CORREL function) for each pair of Independent Variables.

Any variables that are strongly correlated (i.e. which have a Pearson's correlation coefficient > 0.5) are highlighted red.

For any pairs of strongly correlated Independent Variables, it is recommended that only one of the variables is in included in the regression model. Users can choose to use the existing Independent Variables but explantions need to be provided.

10.1.4 Part 4 - Determine effective range and degrees of freedom

R

Analysis - Effective range of Operating energy model

This section automatically calculates the effective range of the Operating Energy Model using the bounding box method. For each Independent Variable, the effective range for the Operating Measurement Period is determined by maximum and minimum values, defined as:

- $x_j.max = max(x_j(t))$
- $x_j.min = min(x_j(t))$

where $x_j(t)$ is the value of the Independent Variable x_j measured during time period t.

The Tool then displays the Operating Measurement Period Effective Range for each Independent Variable next to the range of the Normal Year values for that Independent Variable.

Analysis - Calculated effectiveness of basleine energy model

R

The percentage of the Normal Range that falls within the Operating Measurement Period Effective Range is calculated based on the Independent Variable with the smallest Operating Measurement Range, and has a maximum value of 100%.

Energy savings are maximised when 100% of the Normal Range is within Operating Measurement Period Effective Range.

When less than 100% of the Normal Range is within the Operating Measurement Period Effective Range, data points where the Normal Year value is outside the Operating Measurement Period Effective Range will be automatically excluded from the Normal Year Energy Savings calculation in section 12.1.

In the table below the percentage of Normal Range within Operating Measurement Range, four items are relavent to Regression Analsyis.

- # of valid data points
- # of independent variables
- Degrees of freedom
- Ratio # valid data points to # independent variables

The degrees of freedom are automatically calculated based on the number of valid data points and the number of independent variables.

The tool also examines the ratio of the number of valid data points to the number of independent variables. As per Clause 7A.2(a)(ii) of the Rule, the number of independent observations (valid data points) must be at least the sum of six times the number of Independent Variables. If this requirement is not met, an error message will be displayed and the Number of Certificates will not be calculated.

E

The Tool calculates the Coefficient of Variation automatically based on the energy consumption valeus entered in the Operating Energy Model Data sheet. As per Clause 7A.2(a)(i) of the Rule, the result must be below 15%. If this requirement is not met, an error message will be displayed and the Number of Certificates will not be calculated.

10.1.5 Part 5 - Build energy model

This section is used to record the results of the Regression Analysis/Estimate of the Mean analysis performed on the data in the Operating Energy Model Data sheet.

The software/tool used to generate your regression equation

Enter the name of the software or tool used to generate the regression equation, including the version number where relevant. This is not relevant if you are using the Estimate of the Mean.

Model parameters

R

Enter the results of the Regression Analysis in the table as:

- Variable – variable names are automatically included from defined names provided in section 3.3. The intercept is also included.
- Coefficient – Enter the value of the coefficient for the variable as determined from the Regression Analysis.
- t-statistic - Enter the value of the t-statistic for the variable as determined from the Regression Analysis.
- Check – For each Independent Variable (but excluding the intercept) the value of the t-statistic is compared to the best practice benchmarks. Project proponents need to provide written justifications if any test result is “Warning”.

Values entered must correspond to the output of the Regression Analysis from the software or tool used.

E

The Tool calculates the Estimate of Mean automatically. The calculated value of the Estimate of the Mean will display at this section in the "Coefficient" column of the "Intercept". The value is locked.

Working Formula

R E

The working formula is automatically displayed when the ‘update’ function is selected. The formula uses Independent Variable names and coefficient values for each Independent Variable and the intercept entered above.

The 'Update' procedure must be run to update the working formula after entering or changing any values in the analysis table.

Chart

R E

The chart automatically displays the time series of the measured operating energy (blue series), and compares it against the modelled operating energy (grey series) for the Operating Measurement Period.

Values marked as non-routine measurements are not plotted.

The 'Update' procedure must be run to update the chart after entering or changing any values in the analysis table.

10.1.6 Part 6 – Statistical analysis

Statistical analysis output

R

Enter the following results from the Regression Analysis:

- Coefficient of determination (R^2)
- Adjusted R^2
- Standard error (SE).

Values entered must correspond to the output of the Regression Analysis from the software or tool used.

E

The Tool automatically calculates the standard error.

R E

Based on the values, the Tool automatically calculates the:

- t-value (at 90% confidence level)
- Operating average modelled energy
- absolute modelling precision
- relative modelling precision (based on mean value).

Analysis – Check the Operating energy model meets best practice benchmark

R

The Tool automatically checks the results of the Regression Analysis of Operating Energy Model against the best practice benchmarks, and displays 'pass' or 'fail' based on the following parameters:

- t-statistics of independent variables – 'Pass' if all t-statistics of Independent Variable coefficiencts are >2, or 'warning' otherwise.
- Lesser of R^2 or adjusted R^2 – 'Pass' if the result is >0.75; 'warning' otherwise.
- Relative precision calculated at 90% confidence level – 'Pass' if the result is <±100%; 'warning' otherwise.

If 'Warning' is shown for any checks of the Regression Analysis results above, you will need to provide written justification on the energy model in your M&V plan.

11 Interactive Energy Savings Sheet

11.1 Step 7 – Interactive Energy Savings

This step calculates the effect of the activity on energy consumption outside the measurement boundary.

Identify and define the Interactive Effects of the Activity on energy consumption, including changes to End-User equipment outside the Measurement Boundary.

Provide a description of the Interactive Effects of the project activity. Include details of the end-user equipment outside the measurement boundary that is affected and leads to the Interactive Energy Savings. Include a justification for why the measurement boundary has not been modified to include this equipment.

Select 'yes or 'no' from the drop-down list to answer the question **'Is the End-Use Equipment and its outputs entirely within an air-conditioned space?**'. Further details are required depending on the response, as follows.

Scenario 1 - Yes. End-Use Equipment and its outputs entirely within an air-conditioned space

The Tool can provide a default Interactive Energy Savings Multiplier based on estimates of the reduced load on the HVAC system that is cooling the space containing the End-Use Equipment.

Specify the percentage of the year that the HVAC system is cooling

Enter a value between 0 and 100% to represent the percentage of a typical year for which the HVAC system is running in cooling mode.

Exclude any periods when the HVAC system is providing ventilation only, or is running in reverse cycle heating mode.

Is the HVAC system for the air-conditioned space entirely outside the measurement boundary?

Select 'yes' from the drop down if the HVAC system (including compressor and fans) for the air-conditioned space is entirely outside the measurement boundary defined in section 3.1, or 'no' otherwise.

If the HVAC system for the air-conditioned space is entirely outside the measurement boundary, then none of the electricity used by the system will be included in the metered energy use defined in section 3.3.

Interactive Energy Savings Multiplier

The Tool calculates the Interactive Energy Savings Multiplier based on the information provided, and uses this to estimate average annual Interactive Energy Savings. This is expressed as a percentage of the difference between the Baseline Normal Year Annual Energy Consumption and Operating Normal Year Annual Energy Consumption.

Scenario 2 - No: End-Use Equipment and its outputs are NOT entirely within an air-conditioned space

In this case the Interactive Energy Savings must be calculated manually.

Specify the Average Annual Interactive Energy Savings

Enter the estimated Average Annual Interactive Energy Savings (MWh for electricity and GJ for Gas).

If the Interactive Effects of the project activity are estimated to lead to an increase in energy use outside the measurement boundary, enter the Average Annual Interactive Energy Savings as a negative number.

The Average Annual Interactive Energy Savings must not be more than 10% of the difference between the Baseline Normal Year Annual Energy Consumption and Operating Normal Year Annual Energy Consumption. If they are more than 10%, the Tool will return an error message on the Energy Savings Sheet and the Estimated Number of Certificates will be zero.

Describe how the Average Annual Interactive Energy Savings were calculated

Provide a description of how the Average Annual Interactive Energy Savings were estimated. Included details of formulas used, assumptions made and any other relevant details.

12 Normal Year Energy Savings Sheet

12.1 Step 8 – Calculate Normal Year Energy Savings

12.1.1 Model summary

This step uses Equation 7A.2 to calculate the Normal Year Energy Savings.

The **Baseline Normal Year Annual Energy Consumption** (Electricity or Gas) and **Operating Normal Year Annual Energy Consumption** (Electricity or Gas) are calculated automatically by substituting Normal Year values for each Independent Variable into the Baseline and Operating Energy Models respectively.

The **Annual Interactive Energy Savings** (Electricity or Gas) and **Excluded Energy Savings due to Normal Year values outside effective range** (Electricity or Gas) are automatically calculated from values entered in the Interactive Energy Savings Sheet. The **Normal Year Energy Savings** are automatically calculated according to Equation 7A.2.

12.1.2 Effective Range

The tool displays the Effective Range established based on Baseline Energy Model and Operating Energy Model for each Independent Variable.

12.1.3 Number of measurements taken out

The number of measurements taken out are displayed based on data entries from pevious pages.

12.1.4 Energy Saving table

For each time value in the Normal Year, the Normal Year values of the Independent Variables are then compared to the effective range for that Independent Variable, as defined for the Baseline and Operating Energy Models. If any of the Normal Year values are outside the applicable effective range, or if the Site Constant is not at their standard value, then the Energy Savings for that time value are set to zero.

Similarly, if any of the Normal Year Site Constant value is not at their standard value, the Energy Savings for that time value are set to zero.

The total excluded Energy Savings are then calculated. The results of the calculations are shown in the tables.

The Normal Year Energy Savings are automatically calculated according to Equation 7A.2.

12.1.5 Chart - Calculating gross annual energy savings

The Calculating Gross Annual Energy Savings chart shows the Baseline Normal Year Annual Energy Consumption, Operating Normal Year Annual Energy Consumption and Normal Year Energy Savings. Press the ‘Update’ button to update the values in this chart after any data is changed.

Time values where the Normal Year Energy Savings are zero (due to one or more of the Independent Variables being outside the effective range) are not displayed.

13 Accuracy Factor Sheet

13.1 Step 9 – Assign Accuracy Factor

The Accuracy Factor is the value that corresponds to the relative precision of the Normal Year Energy Savings estimate at a 95% confidence level, as listed in Table A23 of the ESS Rule.

Step 9 uses the calculation of the Normal Year Energy Savings, the Baseline and Operating Model standard error and the number of Measurement Periods in one year to automatically calculate the standard error of the annual savings estimate. It then calculates both the absolute precision and the relative precision of the Normal Year Energy Savings estimate at 95% confidence level. The Accuracy Factor is then assigned as per Table A23 of the ESS Rule.

14 Decay Factor Sheet

The Decay Factor applied for each year can either be the default Decay Factor for that year as per Table A16 of the ESS Rule, or the value for that year from a Persistence Model accepted for use by the Scheme Administrator. The Tool includes a Persistence Model that is accepted for use by

the Scheme Administrator. This model was jointly developed by the Office of Environment and Heritage and the Clean Energy Finance Corporation (formally Low Carbon Australia Limited).

14.1 Step 10 Estimate Activity Lifetime and Decay

Model Type

Default Decay Factor

The default Decay Factors in Table A16 of the ESS Rule are applied by selecting 'Default Decay Factors' from the Model Type drop-down. No further input is required.

Persistence Model

To use the Persistence Model to calculate the End User Equipment life and Decay Factor for each year, select 'Persistence Model' from the Model Type drop-down.

14.1.1 Equipment Characteristics

Select the **Equipment Type**, **Category** and **Sub-Category** that correspond to the activity being implemented.

If there is no Equipment Type, Category and Sub-Category combination that corresponds to the activity, then the Persistence Model cannot be used.

If the activity being implemented includes more than one Equipment Type, Category and Sub-Category, then the Persistence Model must be applied, using the Equipment Type, Category and Sub-Category that gives the most conservative Decay Factors.

14.1.2 Environment and Maintenance Characteristics

Enter the environment and maintenance characteristics by selecting values from each drop-down:

Coastal Location – Select applicable value based on whether the activity being implemented is more or less than 500 metres from the coast.

Equipment Usage – Select the typical equipment usage in hours per week. The available usage regimes will change based on the Equipment Type, Category and Sub-Category combination selected.

Water Hardness – If relevant for the Equipment Type, Category and Sub-Category combination, select the typical water hardness used by the End User Equipment. If not relevant, 'N/A' will be displayed in the drop-down. Available options if relevant are:

- Soft 0-60mg/L salts
- Moderate 61-120mg/L salts
- Hard: Over 121mg/L salts

UV Exposure – If relevant for the Equipment Type, Category and Sub-Category combination, select the typical UV exposure of the End User Equipment. If not relevant, 'N/A' will be displayed in the drop-down. Available selections if relevant are:

- Internal
- External

- Sheltered.

14.1.3 Persistence Model Output

The Persistence Model output is the calculated Decay Factor for each year of the Expected Lifetime of the End User Equipment.

15 Counted Energy Savings Sheet

15.1 Step 11 – Account for Energy Savings for which ESCs have already been created

If Energy Savings Certificates have previously been created for any part of the same Implementation in any year, then the corresponding Energy Savings must be designated as Counted Energy Savings and excluded from overall Energy Savings.

RESA ID under which ESCs were created

Enter the RESA ID under which the ESCs that constitute the Counted Energy Savings were created.

End-Use Equipment for which the ESCs were created

Provide a description of End-Use Equipment for which the ESCs that constitute the Counted Energy Savings were created.

Implementation Date

Enter the Implementation date for the RESA under which the ESCs that constitute the Counted Energy Savings were created.

Other details/dates relevant to the Counted Energy Savings

Provide any other relevant details for the Counted Energy Savings.

Counted Energy Savings:

Enter the Counted Energy Savings for each year of the Implementation. The Implementation years are automatically shown based on information in section 8.1 Step 5 - Implement and Commission Activity.

16 Energy Savings Sheet

16.1 Step 12 – Calculate Energy Savings

The Energy Savings are calculated as per Equation 7A.1 of the ESS Rule.

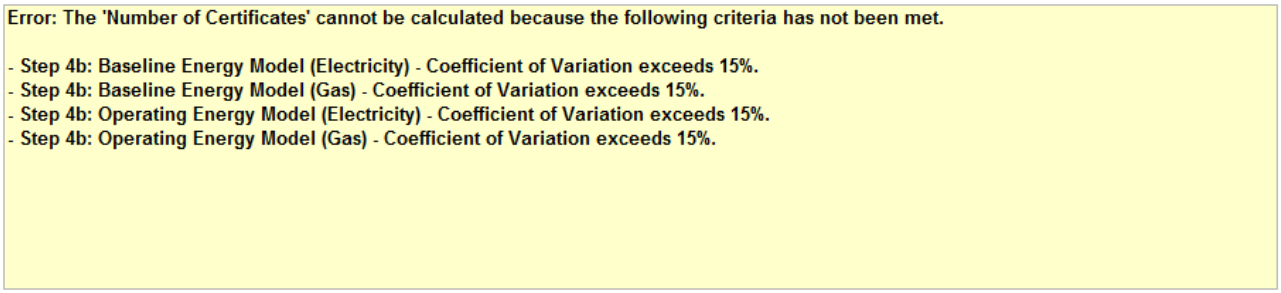
All values required are automatically entered from previous calculations in the Tool.

The total Energy Savings are shown in MWh for electricity and for Gas. Gas Savings are converted automatically to MWh from GJ in this step.

The Estimated Number of Certificates is shown, using a Certificate Conversion Factor of 1.06 for electricity and 0.39 for Gas. If the project is in regional NSW as defined by Table A24 in the Rule, a Regional Network Factor applies to the Estimated Number of Certificates calculated from Electricity Savings.

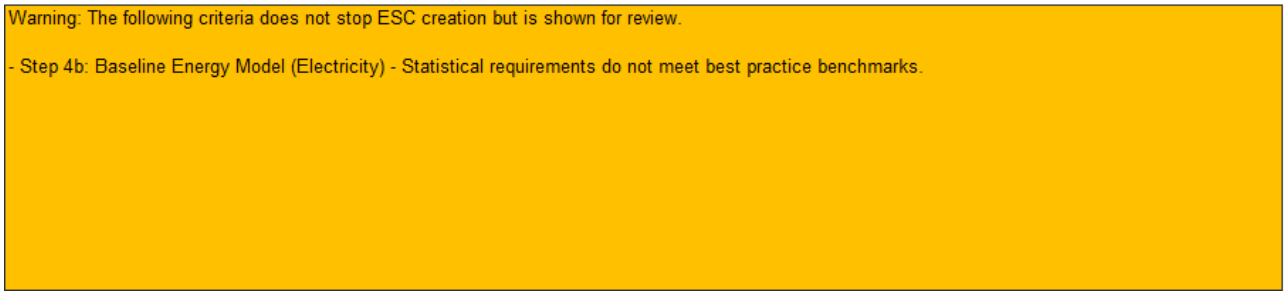
If the Tool is not complete, or any of the requirements of the Tool are not met, the Estimated Number of Certificates is shown as zero. A summary of errors is displayed for each requirement of the Tool that is not met.

Figure 16-1 Example of the summary of errors



If the Tool is complete but the data fail to meet best practice recommendations, ESCs can still be calculated but users need to review the data and provide a justification if required. A list of warnings for each recommendation that is not met is shown.

Figure 16-2 Example of the summary of warnings



Once the Tool is complete, refer to the IPART Method Guide PIAM&V for the accreditation and ESC creation procedures.