Project Impact Assessment with Measurement and Verification Tool

User Guide

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1 About this guide

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 1.0 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 regression analysis.

This guide should be used by:

- applicants who are seeking accreditation using the PIAM&V Tool, and
- users already accredited (Accredited Certificate Providers) using the PIAM&V Tool, to assist them in accurately calculating energy savings for a new 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 particular **Appendix D – Detailed calculation instructions and evidence requirements** and **Appendix E – Establishing energy models by regression analysis.**

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, Concepts and Options for Determining Energy and Water Savings*, Volume I, 2012 (IPMVP), published by Efficiency Valuation Organization [5].

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

List of Acronyms

The abbreviations and acronyms used in this Guide have the following meaning:

ACP	Accredited Certificate Provider
ESC	Energy Savings Certificate
IPART	Independent Pricing and Regulatory Tribunal of New South Wales
IPMVP	International Performance Measurement and Verification Protocol
MWh	megawatt hour
NMI	national meter identifier
PIAM&V	Project Impact Assessment with Measurement and Verification
RESA	Recognised Energy Saving Activity
ESS	Energy Savings Scheme

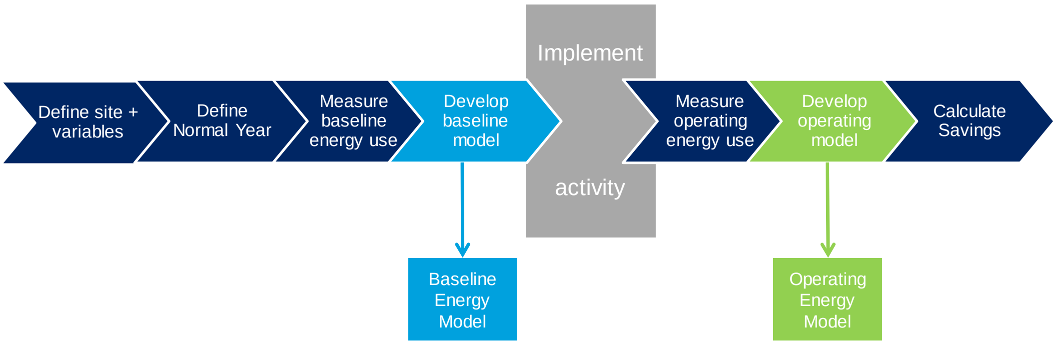
2 Introduction

The PIAM&V Tool is a straightforward 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, as represented in Figure 2.1, with a main chapter heading for each worksheet of the Tool.

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 model developed. However, partially completed versions of the Tool may be submitted as part of an application for accreditation – refer to the *Method Guide: PIAM&V* for more details.

Figure 2.1 Development of baseline and operating energy models from measurements



2.1 Computer system minimum requirements

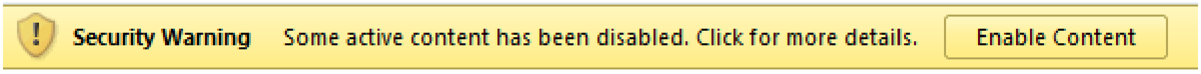
The minimum requirements to run the PIAM&V Tool are:

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

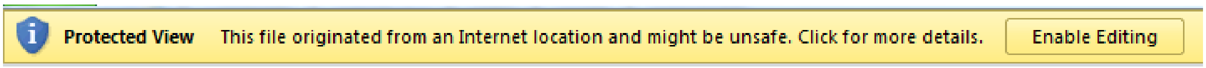
Note: The Tool is not supported on Microsoft Office for Mac.

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.



- 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.

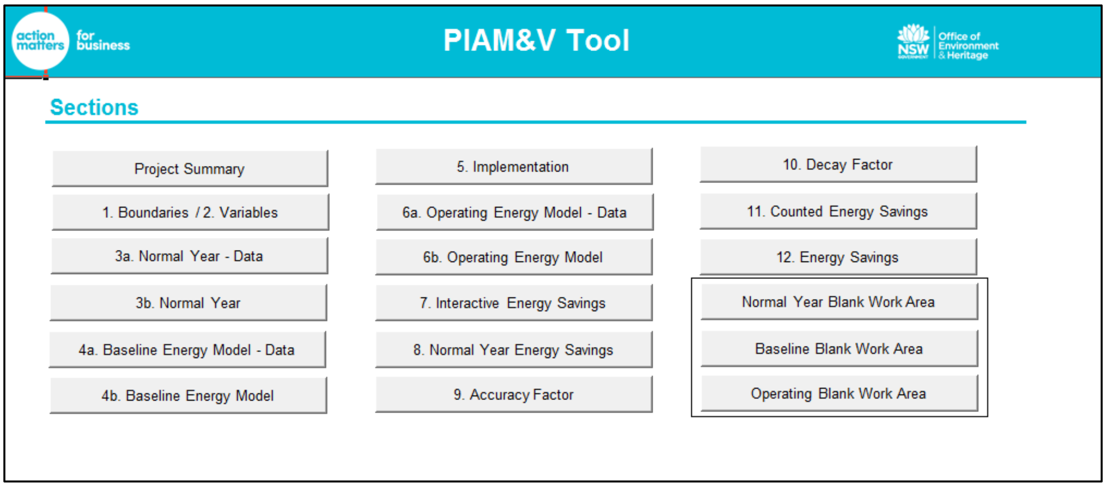


- The location to which the Tool is saved from may need to be added to the Excel Trusted Locations list to ensure full functionality. Trusted Location settings can be changed in Excel 2010 in the Trusted Location tab in the Trust Centre.

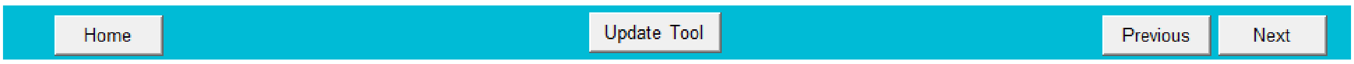
2.2 Tool navigation and functions

The Tool has the following navigational and functional options:

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



- On each sheet, the Tool has the following navigational options:



  - Home – Return to menu page
  - Update Tool (where relevant) – Updates the Tool based on the inputs. This function is discussed further in section 2.2.1.

- 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.

Regression

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

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

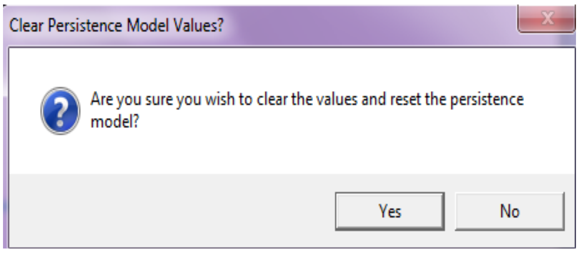
Brief overview of RESA:

- Yellow warning/critical information boxes – These are locked boxes that highlight key information to assist the user, e.g.

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.

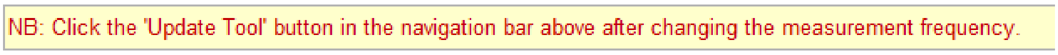
- Clear All Inputs – Removes all inputs and resets the persistence model. This is only available on Step 10 of the Tool when using the persistence model. Clicking on this button generates a confirmation message before inputs are reset.

Clear All Inputs



2.2.1 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.

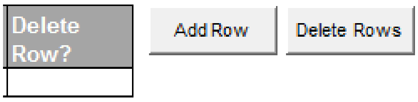


Some charts and formulas also require the Tool to be updated. Where this is the case, an update button is provided.

2.2.2 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.



2.2.3 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.

3 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.

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 multisite RESAs. A sampling approach is not currently supported by the PIAM&V Tool.

Method for developing baseline energy model

For Version 1.0 of the Tool, the method for developing the baseline energy model must be 'Regression' and the selection for this input is locked at this value.

Method for developing operating energy model

For Version 1.0 of the Tool, the method for developing the operating energy model must be 'Regression' and the selection for this input is locked at this value.

Calculation sub-method

For Version 1.0 of the Tool, the calculation sub-method must be 'Upfront/Normal Year' and the selection for this input is locked at this value.

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 17).

A value will only be displayed at this location once all input conditions are met. Refer to section 17 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.

Name of Energy Saver

Enter the name of the Original Energy Saver, or Nominated Energy Saver. Refer to section 3.1 of the *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 2.2.2.

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.

Additional rows may be added or removed from the table as described in section 2.2.2.

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 8.1.7).

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 *Method Guide: PIAM&V* for requirements on 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.

4 Boundaries and Variables Sheet

4.1 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*.

4.2 Step 2a – Define Energy Model Data Frequency

Select the measurement frequency for the models from the drop-down list. Both the baseline and 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.

4.3 Step 2b – Define Variables

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 and operating energy models (see sections 7.1 and 10.1).

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, and this field is locked to this unit. Data measured in other units must be converted to MWh 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.
- Conversion to Model Frequency – Describe any conversion of measured data to be consistent with measurement frequency defined for the Tool in section 4.2.

- 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 2.2.2.

Independent Variables

Identify and define *p* Independent Variables, which vary over time under normal operating conditions, and must be measured during measurement periods.

After changing the Independent Variables, click the 'Update Tool' button in the navigation bar.

- 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 4.2.

- 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 2.2.2.

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.

- 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 4.2.
- 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 2.2.2.

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.

- 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 2.2.2.

5 Normal Year Data Sheet

5.1 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 4.2.

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

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.

6 Normal Year Sheet

6.1 Step 3b – Establish Normal Year of Operating Conditions

6.1.1 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

Define the data sources and time periods covered and how they were manipulated, if at all, to determine the Normal Year data set. 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 2.2.2.

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.

6.1.2 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 4.2. 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, both the baseline and operating energy models should be developed to have an effective range that covers all Normal Year data (see section 8.1.4).

7 Baseline Energy Model Data Sheet

7.1 Step 4a – Establish 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 through regression analysis, but should also include any measurements that were removed as non-routine measurements before the regression analysis.

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, 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.

Ensure values are stored as date and time values in Excel (rather than text). Values can be formatted according to the measurement frequency of the data, for example DD/MM/YY for daily measurement frequency, or DD/MM/YY hh:mm for hourly measurement frequency.

For each data point, if the measurement was removed from the data set before the regression 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, and number formatting then applied as required.

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

8 Baseline Energy Model Sheet

8.1 Step 4b – Establish Baseline Energy Model

This worksheet is used to enter the results of the regression analysis performed on the data in the Baseline Energy Model Data 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, but the equation may have single or multiple independent variables.

8.1.1 Part 1 - Measure energy consumption and independent variables and monitor Site Constants over the measurement period

The Tool calculates the start date, end date, measurement period (in years) and number of measurements in the measurement period, based on the data 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.

8.1.2 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 calculates the Non Routine Adjustments as a proportion of the Measurement Period. As per Table A22 of the ESS Rule, this proportion must be less than 20%, otherwise an error message is displayed.

8.1.3 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.

8.1.4 Part 4 - Determine effective range and degrees of freedom

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.

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 13.1.

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

8.1.5 Part 5 - Use regression to estimate energy model

This section is used to record the results of the regression analysis performed on the data in the Baseline Energy Model Data sheet.

What software/tool was used to generate your regression equation

Enter the name of the software or tool used to generate the regression equation, including version number where relevant.

In the table, enter the results of the regression analysis as:

- Variable – variable names are automatically included from defined names provided in section 4.3. 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 minimum requirement in Table A22 of the ESS Rule. A result of 'pass' is displayed for values > 2, and 'fail' is displayed for all other values. The regression analysis must be repeated until all Independent Variables display 'pass'.

Values entered must correspond to the output of the regression analysis from the software or tool used.

Working Formula

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 regression analysis table.

Chart

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 regression analysis table.

Outputs of Regression Analysis

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.

Based on the entered values, the Tool automatically calculates the:

- t-value (at 95% confidence level)
- baseline average modelled energy
- absolute modelling precision
- relative modelling precision (based on mean value).

8.1.6 Analysis - Check the baseline energy model meets minimum requirements

Modelling Criteria and Minimum Requirement

The Tool automatically checks the results of the regression analysis against the requirements in Table A22 of the ESS Rule, and displays 'pass' or 'fail' based on the following parameters:

- t-statistics of independent variables – 'Pass' if all values in section 8.1.5 are shown as pass; 'fail' otherwise.
- Lesser of R^2 or adjusted R^2 – 'Pass' if the result is >0.75; 'fail' otherwise.
- Relative precision calculated at 95% confidence level – 'Pass' if the result is <±100%; 'fail' otherwise.
- Non-routine adjustment ratio – As calculated in section 8.1.2. 'Pass' if the result is <20%; 'fail' otherwise.

The Estimated Number of Certificates calculated in section 17.1 is shown as zero unless 'pass' is shown for all checks of the regression analysis results above.

8.1.7 Analysis - Estimated accuracy factor

This section allows the user to estimate the Accuracy Factor that could be applied in section 14 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 14 only.

9 Implementation Sheet

9.1 Step 5 - Implement and Commission Activity

Implementation date

The Implementation Date is automatically linked to the value entered in Section 3 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 3 Project Summary Sheet, this value must be updated to the actual Implementation Date following implementation.

10 Operating Energy Model Data Sheet

10.1 Step 6a – Establish 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, but it must also include any non-routine measurements that were removed before the regression 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, 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.

Ensure values are stored as date and time values in Excel (rather than text). Values can be formatted according to the measurement frequency of the data, for example DD/MM/YY for daily measurement frequency, or DD/MM/YY hh:mm for hourly measurement frequency.

For each data point, if the measurement was removed from the data set before the regression 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, and number formatting then applied as required.

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

11 Operating Energy Model Sheet

11.1 Step 6b – Establish Operating Energy Model

This worksheet is used to enter the results of the regression analysis performed on the data in the Operating Energy Model Data 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, but the equation may have single or multiple independent variables.

11.1.1 Part 1 - Measure energy consumption and independent variables and monitor Site Constants over the measurement period

The Tool calculates the start date, end date, measurement period (in years) and number of measurements in the measurement period, based on the data 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.

11.1.2 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 calculates the Non Routine Adjustments as a proportion of the Measurement Period. As per Table A22 of the ESS Rule, this proportion must be less than 20%; otherwise an error message is displayed.

11.1.3 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.

11.1.4 Part 4 - Determine effective range and degrees of freedom

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.

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 13.1.

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

11.1.5 Part 5 - Use regression to estimate energy model

This section is used to record the results of the regression analysis that is performed on the data in the Operating Energy Model Data sheet.

What software/tool was used to generate your regression equation

Enter the name of the software or tool used to generate the regression equation, including version number where relevant.

In the table, enter the results of the regression analysis as:

- Variable – variable names are automatically included from defined names provided in section 4.3. 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 minimum requirement in Table A22 of the ESS Rule. A result of 'pass' is displayed for values > 2, and 'fail' is displayed for all other values. The regression analysis must be repeated until all Independent Variables display 'pass'.

Values entered must correspond to the output of the regression analysis from the software or tool used.

Working Formula

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 regression analysis table.

Chart

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 regression analysis table.

Outputs of Regression Analysis

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.

Based on the entered values, the Tool automatically calculates the:

- t-value (at 95% confidence level)
- operating average modelled energy
- absolute modelling precision
- relative modelling precision (based on mean value).

11.1.6 Analysis - Check the Operating energy model meets minimum requirements

Modelling Criteria and Minimum Requirement

The Tool automatically checks the results of the regression analysis against the requirements in Table A22 of the ESS Rule, and displays 'pass' or 'fail' based on the following parameters:

- t-statistics of independent variables – 'Pass' if all values in section 11.1.5 are shown as pass; 'fail' otherwise.
- Lesser of R^2 or adjusted R^2 – 'Pass' if the result is >0.75; 'fail' otherwise.
- Relative precision calculated at 95% confidence level – 'Pass' if the result is <±100%; 'fail' otherwise.
- Non-routine adjustment ratio – As calculated in section 11.1.2. 'Pass' if the result is <20%; 'fail' otherwise.

The Estimated Number of Certificates calculated in section 17.1 is shown as zero unless 'pass' is shown for all checks of the regression analysis results above.

12 Interactive Energy Savings Sheet

12.1 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.

12.1.1 End-Use Equipment and its outputs entirely within an air-conditioned space

In this case, 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 4.1, 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 4.3.

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.

12.1.2 End-Use Equipment and its outputs 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 (MWh).

Enter the estimated Average Annual Interactive Energy Savings.

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.

13 Normal Year Energy Savings Sheet

13.1 Step 8 – Calculate Normal Year Energy Savings

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

The Baseline Normal Year Annual Energy Consumption and Operating Normal Year Annual Energy Consumption 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 are automatically calculated from values entered in the Interactive Energy Savings Sheet.

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, then 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.

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.

14 Accuracy Factor Sheet

14.1 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.

15 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).

15.1 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.

15.2 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.

15.2.1 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.

15.2.2 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.

15.2.3 Persistence Model Output

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

16 Counted Energy Savings Sheet

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

If Energy Savings Certificates have previously been created for 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 9.1 Step 5 - Implement and Commission Activity.

17 Energy Savings Sheet

17.1 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.

The Estimated Number of Certificates is shown, using a Certificate Conversion Factor of 1.06.

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 warning message is displayed for each requirement of the Tool that is not met.

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